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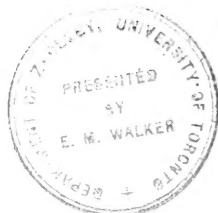
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REPORT
OF THE
DOMINION ENTOMOLOGIST

ARTHUR GIBSON, F.R.S.C., F.E.S.A.

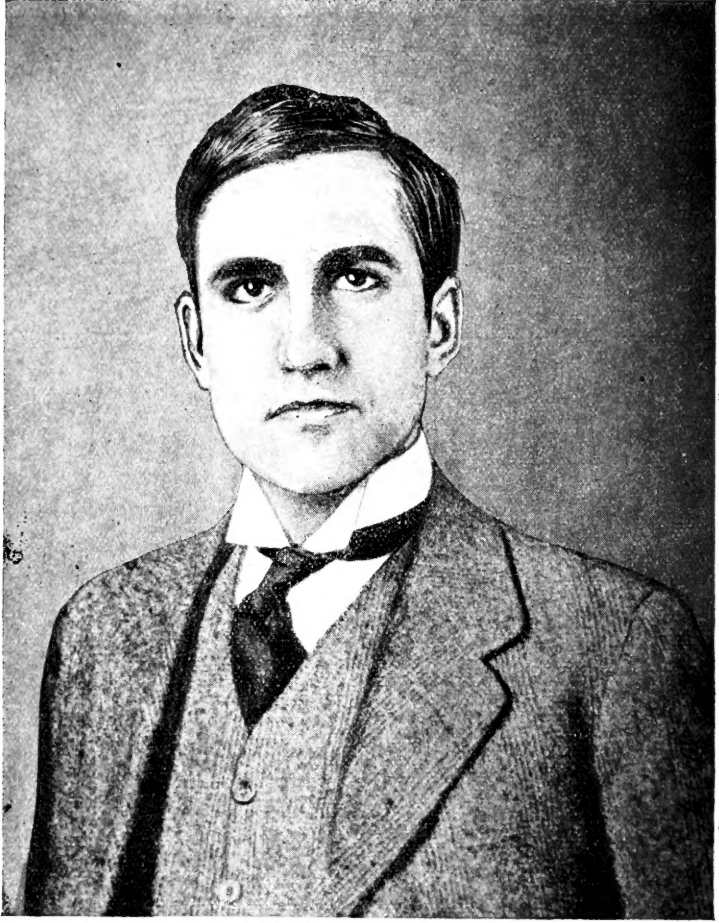
FOR THE

Two Years 1919 and 1920



OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1923

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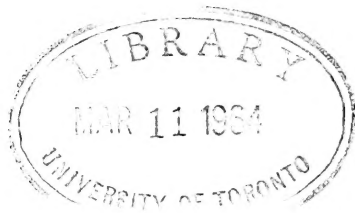
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REPORT OF THE DOMINION ENTOMOLOGIST

For the Two Years Ending March 31, 1921.

OTTAWA, March 31, 1921.

The Honourable,
The Minister of Agriculture,
Ottawa.

Sir,—I have the honour to submit my first report as Dominion Entomologist, covering the work of the officers of the Entomological Branch during the two fiscal years ending March 31, 1921.

Before discussing the work of the branch during this period, I wish to record my sincere regret in the death of Charles Gordon Hewitt, who occupied the position of Dominion Entomologist and Consulting Zoologist from 1909 to 1920. His death occurred about 11 p.m. on February 29, 1920.

Dr. Hewitt was born near Macclesfield, England, on February 23, 1885. He received his education in the Macclesfield Grammar school and Manchester University, which latter institution conferred upon him the degree of Doctor of Science. In 1909, he left England for Canada, having received the appointment of Dominion Entomologist. In 1916, his title was changed to that of Dominion Entomologist and Consulting Zoologist. During his eleven years of office he developed the Dominion entomological service from a very small division attached to the Experimental Farms Branch to an important separate branch of the department. This development is instanced in the establishment of important divisions at Ottawa; such as the Division of Field Crop and Garden Insects; the Division of Forest Insects; the Division of Foreign Pests Suppression, and the Division of Systematic Entomology, all under the immediate direction of highly qualified chiefs. In addition to these divisions of the work special officers have been given charge of such lines of study as Natural Control Investigations, Insecticide Investigations and Stored Product Insect Investigations. In the various provinces, too, field or regional laboratories have been established with trained entomologists in charge who study local problems and disseminate information of value to agriculturists, horticulturists, lumbermen and others. In 1909, he recognized the importance of legislation to prevent the introduction or spreading of insect pests and diseases destructive to vegetation, and as a result Parliament passed the Destructive Insect and Pest Act in May, 1910. Under the regulations of this Act inspectors were appointed to deal with the threatened spread of the brown tail moth in the Maritime Provinces, and provisions were made for the prohibition, fumigation, or inspection of nursery stock at definite ports of entry. In addition to the brown tail moth scouting work which he developed in co-operation with the provinces of Nova Scotia and New Brunswick, he also arranged for the collecting in Massachusetts and establishment in Eastern Canada of thousands of parasitic and predaceous enemies of the brown tail and gipsy moths.

Dr. Hewitt was keenly interested in medical entomology and accomplished much useful work on problems relating to the house-fly, mosquitoes, ticks and other animals which spread disease.

He was the author of important books and memoirs. His chief published work is the well-known book on the house-fly, of which there were two editions. A smaller book on the same subject appeared later as one of the Cambridge Manuals of Science and Literature. His departmental publications consist of a series of annual reports (1910-1918) and bulletins, chief among the latter of which are those on the Honey Bee and the Large Larch Sawfly. Just before he died he completed an important volume on the Conservation of the Wild Life of Canada, which has since appeared in book form. The publication in 1919 of the various parts of an important volume on the insects collected by the Canadian Arctic Expedition, 1913-1918, was brought about under his direction.

Dr. Hewitt's reputation was by no means confined to Canada. In addition to a wide connection among scientific workers in England, his outstanding abilities were soon recognized by entomologists in the United States, where economic entomology particularly has reached a high development. In the year 1913, he was honoured by being elected a Fellow of the Entomological Society of America. In 1915, he was elected President of the American Association of Economic Entomologists. In Canada, in 1913, he accepted the Presidency of the Entomological Society of Ontario and in the same year was elected a Fellow of the Royal Society of Canada. In the following year he was appointed Honorary Treasurer of the latter society which office he held at the time of his death. He was a Fellow of the Entomological Society of London (England); a Corresponding Member of the Zoological Society of London, and Honorary Fellow of the Royal Society for the Protection of Birds, London, (England). He was a recognized student of wild life preservation and rendered valued services in the capacity of Secretary of the Advisory Board on Wild Life Protection. The gold medal of the Royal Society for the Protection of Birds was presented to Dr. Hewitt on March 12, 1918, in grateful recognition of successful efforts in furthering the treaty, between Canada and the United States, for the protection of migratory birds.

WORK OF THE BRANCH

The work of the branch during the two fiscal years covered by this report related particularly to the following:—

I. Investigations:—

- (a) Insects affecting field and garden crops.
- (b) Insects affecting forest and shade trees.
- (c) Insects affecting fruit crops.
- (d) Insects affecting greenhouse and ornamental plants.
- (e) Insects affecting man and domestic animals.
- (f) Insecticides.
- (g) The natural control of insects.

II. The administration of the regulations under the Destructive Insect and Pest Act, including:—

- (a) Inspection and fumigation of foreign nursery stock and other plant products.
- (b) Field work against the brown tail moth in Eastern Canada.
- (c) Amendments to Regulations.

III. Maintenance of the National Collection of Insects.

IV. Branch laboratories.

V. Miscellaneous:—

- (a) Gopher control by means of chlorine.
- (b) Indian orchard work in British Columbia.
- (c) Travelling.
- (d) Advisory Board on Wild Life Protection.
- (e) Publications.
- (f) Staff.

I—INVESTIGATIONS.

Important progress has been made in the investigations of insect pests and their control which have been conducted at Ottawa and at the field laboratories established in the various provinces, excepting Prince Edward Island:

INSECTS AFFECTING FIELD AND GARDEN CROPS

The work of the Division of Field Crop and Garden Insects for the two years ending March, 1921, was carried on under my immediate direction, in 1919 as Chief of the Division and in 1920 as Dominion Entomologist. The insects which occurred in destructive numbers and which occupied the attention of officers connected with the division are the following:—

1919

CUTWORMS.—These caterpillars were the cause of much damage in various parts of Canada, particularly in the Prairie Provinces. In the eastern provinces no very serious outbreaks occurred. In Ontario, the glassy cutworm, *Sidemia devastator* Brace, was rather abundant, and in Middlesex county caused important injury. Near Pond Mills, Ont., an eight-acre field of corn was entirely destroyed. The field had been in sod for four years. Mr. H. F. Hudson, in charge of the Strathroy, Ont., laboratory had an opportunity of demonstrating the value of poisoned bran for surface-feeding cutworms. A three-acre corn field was severely infested in early June; in fact the owner had given up all hope of a crop. Two applications of bait, however, at the rate of 20 pounds to the acre, one on June 4, the other on June 7, stopped the outbreak completely. Unfortunately the species of cutworm was not determined but a moth reared from material collected in the field has been determined by me as *Euxoa personata* Morr., a species which has been destructive in Manitoba but of which we have no economic records from Ontario. The variegated cutworm, *Lycophotia margaritosa* Hbn., was complained of from a few localities in Ontario, chiefly owing to injury to corn and tomatoes.

In the Prairie Provinces, cutworms were very numerous and it was in these provinces that the important damage took place. In Manitoba and Saskatchewan, according to Mr. N. Criddle, in charge of the Treesbank, Man., laboratory, who personally investigated many outbreaks, probably half a million acres of crops were destroyed. In Manitoba the red-backed cutworm, *Euxoa ochrogaster* Gn., was particularly destructive in oat fields, many of which had to be resown. In the district of Lumsden, Sask., it was estimated by Mr. Arthur Anslow, president of the local agricultural society, that fully 2,000 acres of crops were destroyed. In the province of Alberta, the pale western cutworm, *Porosagrotis orthogonia* Morr., was again very prevalent and responsible for the greatest percentage of the destruction. The chief area of infestation was north from Taber in the Retlaw-Lomond districts. In this area it was estimated that 25 per cent of the crops were destroyed.

In addition, important injury was caused by the red-backed cutworm, particularly in the neighbourhood of High River, Claresholm and Pincher Creek, Alta. In the district of Blackfalds and Blackie, Alta., the black army cutworm, *Agrotis ferrica* Tausch, was found in association with the red-backed cutworm. At the former place injury was effected, particularly to sweet clover during the latter part of May. Another species of cutworm, hitherto apparently unrecorded as an economic pest, namely, *Euxoa tristicula* Morr., also occurred in Alberta, particularly in the neighbourhood of Blackie, Lochend, Retlaw and Stettler. Mr. E. H. Strickland, in charge of the entomological laboratory at Lethbridge, Alta., visited the areas in April and May, but the larvæ were not present in sufficient numbers to be considered a serious menace to spring crops. He estimated the loss from cutworm outbreaks in Alberta, in 1919, as amounting to from three to five million dollars.

From British Columbia specimens of the dark-sided cutworm, *Euxoa messoria* Harr., were received. The cutworms were destructive in gardens, particularly in the district of Lillooet. Some of the larvæ were affected by a bacterial disease. In this connection it is of interest to record the occurrence of the fungus *Entomophthora megaspermum* Cohn,* in British Columbia, described in 1873, and never reported since. Diseased noctuid larvæ were found by Mr. E. R. Buckell, at Keremeos near Penticton. As they were found hanging from bushes, the larvæ, apparently, cannot be considered to have been true cutworms.

GRASSHOPPERS. The worst outbreak of many years occurred in 1919 in the prairie provinces, the species involved being the roadside grasshopper, *Camnula pellucida* Scudd., and the lesser migratory grasshopper, *Melanoplus atlantis* Riley. According to Mr. Criddle, the outbreak in Manitoba was the worst, of which he had record, since 1875. Soon after the grasshoppers appeared Mr. Criddle and Dr. A. E. Cameron, in charge of the Saskatoon laboratory, rendered valuable assistance to farmers in southwestern Manitoba and southeastern Saskatchewan. Meetings were held and demonstrations made in the method of making and distributing poisoned baits to destroy grasshoppers. Owing to the suddenness of the outbreak and the lack of sufficient poison, etc., our officers were handicapped at first; but an excellent organization was soon put into effect and with the assistance rendered from the Provincial Department of Agriculture of Saskatchewan and the Provincial Department of Agriculture of Manitoba, excellent results were obtained and much crop was saved. Mr. Criddle estimated that the total area infested by grasshoppers in Manitoba was in excess of 500,000 acres, of which by far the greatest proportion was situated in the southwestern corner.

In the province of Saskatchewan, Dr. Cameron and Mr. M. P. Tullis, of the Provincial Department of Agriculture, reported that an area of approximately 1,500 square miles was more or less involved in the outbreak, extending from the Manitoba and United States boundaries in the southeastern part of the provinces and following a northwesterly direction to the vicinity of Saskatoon. About 75,000 acres of growing wheat were destroyed within the infested area. A fuller account of the outbreak of grasshoppers in the prairie provinces in 1919 was published in Circular No. 13, of the Entomological Branch.

In Alberta, serious infestation occurred in areas west and south of Lethbridge. The most important species in the grain fields was the lesser migratory grasshopper, although the roadside grasshopper was abundant in some sections, particularly on headlands.

In British Columbia, grasshoppers were reported from four widely separated districts, viz., in the Bridesville-Rock Creek area; at Celesta on Shuswap

* Determined by Dr. A. T. Speare, U.S. Bureau of Entomology, Washington, D.C.

lake; in the Chilcotin district, 150 miles north of Ashcroft; and in the Huntington area of the Fraser river valley. At Bridesville, the roadside grasshopper was the chief injurious species involved; at Celesta it was the lesser migratory grasshopper; in the Chilcotin the roadside grasshopper; and in the Fraser valley, the red-legged grasshopper.

In the province of Ontario grasshoppers caused some damage particularly to vegetable crops in gardens.

THE WESTERN WHEAT STEM SAWFLY, *Cephus cinctus* Nort. In the provinces of Manitoba and Saskatchewan a very serious outbreak of this insect occurred in 1919. According to Mr. Criddle, this outbreak was the worst of which he had record. In southwestern Manitoba and southeastern Saskatchewan many complaints of injury were received and fields in infested areas were personally investigated by Mr. Criddle. In one locality near Melita, Man., it was estimated that in some fields of wheat the loss from the attack of this insect was as high as 60 per cent of the crop.

THE BEET WEBWORM, *Loxostege sticticalis* L.—Many inquiries were received from the prairie provinces regarding this insect. The moths from overwintered material appeared in countless thousands in May and June, and much anxiety was felt among farmers as to possible injury to grain crops later in the season. Caterpillars from eggs laid by these moths were very numerous in August, but as has been the case with similar outbreaks in other years practically no injury was effected to field crops other than rather unimportant injury to alfalfa. In gardens, however, much injury was caused to beets, peas, carrots, corn, onions, etc. In fields, weeds such as lamb's quarters and Russian thistle were the favourite food. In view of the widespread interest in this insect a Crop Protection Leaflet (No. 12) was prepared by Messrs. Strickland and Criddle.

INSECTS AFFECTING CORN. The appearance of our warning poster regarding the European corn borer, *Pyrausta nubilalis* Hbn., was responsible for the receipt of various borers found working in corn. The potato stem-borer, *Gortyna micacea* Esp., was frequently sent in from Nova Scotia and New Brunswick. It was found chiefly in gardens feeding on corn, potatoes, rhubarb, tomatoes, etc. The burdock borer, *Papaipema cataphracta* Grt., was more or less abundant in Ontario, feeding within the stems of such plants as dahlias, hollyhock, rhubarb, tomatoes, corn, etc., and was assumed by the senders to be the European corn borer. Mr. Criddle, forwarded a larva which he had received from Winnipeg, Man., with the statement that it had been found in considerable numbers attacking growing corn, first the leaves and later the stem through which it bored. Mr. A. V. Mitchener, of the Manitoba Agricultural College, sent us further specimens, and Mr. J. B. Wallis, also of Winnipeg, kindly forwarded us a moth which he had reared from similar larvæ. The species, therefore, was determined as *Helotropha reniformis* Grt. This species is referred to under the name of the western corn borer in Entomological Circular No. 14. From a borer in corn forwarded from Picton, N.S., another noctuid moth was reared, namely, *Apamea nictitans americana* Speyer. In late summer and in autumn the insect which was most conspicuous in corn and which was thought to be the European corn borer was the well known corn ear-worm, *Heliothis obsoleta* Fab. This insect was more than usually abundant in Ontario, the injury being confined largely to late planted corn. In some districts the ears of dent corn were injured more than were those of flint corn.

THE POTATO LEAF HOPPER, *Empoasca mali* Le B. An important outbreak of this insect took place in Eastern Canada, particularly in the province of

Ontario. Mr. Hudson investigated outbreaks in his immediate district of Strathroy and reported that in some fields the yield was decreased by fully 25 per cent owing to the attack. In sections where the insect was prevalent, beans were also affected to an important degree. At the Vineland Station, Ont., laboratory, Mr. Ross begun a study of the life-history and habits of the insect.

THE CHINCH BUG, *Blissus leucopterus* Say. It is some years since this insect appeared in Canada in noticeable numbers. In 1919, Mr. W. A. Ross, in charge of the Vineland Station, Ont., laboratory, reported an important outbreak in Gainsboro township, Lincoln county, Ont. Meadow grasses, particularly timothy were in some instances killed outright. Oats were injured to a considerable extent; some damage was also effected to corn. Diseased specimens of the chinch bug sent to Ottawa for examination indicated that they had been destroyed by the well known chinch bug fungus, *Sporotrichum globuliferum* Speg. Mr. Ross estimated that the percentage of mortality from this disease varied from 25 to 75 per cent in the fields examined.

THE ARMY WORM, *Cirphis unipuncta* Haw. A rather important outbreak of this insect occurred in Prince Edward county, Ont., namely, throughout Hallowell district as far east as Bloomfield, the chief damage being to corn and oats, particularly the latter. This is the only outbreak of which we have record in 1919. The moths of this insect, according to a statement made by Mr. A. F. Winn at a recent meeting of the Entomological Society of Ontario, were rather abundant in the autumn of that year, in the district of Montreal.

THE COLORADO POTATO BEETLE, *Leptinotarsa decemlineata* Say. During 1919, this important enemy of the potato was enormously abundant in many parts of Canada, particularly in the eastern provinces. The beetles overwintered in excellent condition and in the early part of the season caused much damage to tomato plants. Soon, the conspicuous egg masses were noticed in large numbers, and where spraying was not in practice the potato vines were soon destroyed. In British Columbia, the Colorado potato beetle was reported for the first time, having been found in the southwestern corner of the Kootenay district. Close biological studies of the insect were incepted at Ottawa.

THE HESSIAN FLY, *Mayetiola destructor* Say. An important outbreak of this insect took place in the province of Ontario, particularly in the extreme western counties, as for instance in Essex county. Mr. Hudson visited many of the fields and gave advice to the growers in the various districts.

THE IMPORTED ONION MAGGOT, *Hylemyia antiqua* Mg. Experimental work in the control of this insect was conducted during 1919, particularly in the province of British Columbia. As indicated in the report of the Dominion Entomologist for the two years ending March, 1918, a poisoned bait consisting of sodium arsenite, molasses and water, has been used successfully under field conditions in eastern Ontario. In British Columbia, however, this remedy has not given the same results. In 1918, Mr. Treherne again tested this remedy in this later province, and was unable to get satisfactory control of the onion maggot under field conditions which prevailed that year in the Vernon district. He secured data of value, however, on the influence of a suitable type of volunteer onion as a trap crop for the first generation of the insect to lay their eggs upon.

THE CABBAGE ROOT MAGGOT, *Hylemyia brassicae* Bouché. In 1919, further investigational work was conducted on the cabbage root maggot both in Eastern and Western Canada. Following experiments of a comparatively small scale, in 1916, 1917 and 1918, with corrosive sublimate, large fields of cabbages in the Ottawa district were treated with strengths of commercial corrosive sublimate

mixture varying from one ounce in four gallons of water to one ounce in ten gallons of water, some blocks of plants having four treatments, others only three. The results from these experiments indicated that in corrosive sublimate we have an excellent remedy for the control of the cabbage root maggot. There was practically no difference in the plots treated with the various strengths. The weakest solution, namely, one ounce in ten gallons of water, gave excellent results and three applications were found to be sufficient, the first being made on the fourth day after planting, the second six days later, and the third ten days after the second, about one-half a cupful of the mixture being poured around the base of the stem of each plant on each occasion. In the province of British Columbia, Mr. Treherne also tested the value of corrosive sublimate in the district of Armstrong, particularly for cauliflowers. The results of these experiments were, in general, similar to those obtained in Eastern Canada, and demonstrated that this remedy was equally valuable in the province of British Columbia.

OTHER FIELD CROP PESTS. The cabbage worm, *Pieris rapae* L., and the diamond back moth, *Plutella maculipennis* Curt., were abundant throughout Canada and caused much damage to cruciferous crops. In the prairie provinces, the red turnip beetle, *Entomocelis adonidis* Fab., was freely complained of, the particular injury being to radishes and turnips. In Ontario, the onion thrips, *Thrips tabaci* Lind., caused important injury. Mr. Ross reported exceptional abundance of the larvæ of the clover leaf weevil, *Phytonomus punctatus* Gyll., particularly in the Niagara district. Mr. Hudson also investigated outbreaks which occurred in the southwestern part of Ontario, particularly Delaware township. By the end of May, however, a fungus disease appeared and completely destroyed the grubs, thus in most fields preventing serious injury. The tarnished plant bug, *Lygus pratensis* L., was exceptionally abundant in 1919. At Kingston, Ont, spinach grown for seed was injured to such an extent that the plants failed to produce any seed. Ornamental plants, such as asters and dahlias, were in many sections a complete failure from the result of attack by this insect.

1920

CUTWORMS. In all the provinces, these caterpillars were responsible for important injury in 1920. Numerous reports were received from the eastern provinces regarding injury to vegetable crops, such as peas, beans, beets, cabbages, tomatoes, etc., the chief destructive species being the red-backed cutworm, *Euxoa ochrogaster* Gn., and the striped cutworm, *Euxoa tessellata* Harr. From Manitoba and Saskatchewan comparatively few reports of serious injury were received. The red-backed cutworm was the species mostly complained of. In June, considerable injury was effected to wheat, in the district of Piapot, in southwestern Saskatchewan, one correspondent reporting that about two-thirds of a ninety-acre field was destroyed. No larvæ were received, but from information at hand we think the species responsible for this injury was the pale western cutworm, *Porosagrotis orthogonia* Morr. In the province of Alberta, the latter species again caused serious losses. Mr. Strickland reported that by May 23, 50 per cent of the crops on summer-fallow around Retlaw, Alta., had been destroyed. The pest moved further westward and from Granum to Pincher Creek, Alta., a new and serious outbreak was reported. The species, *Euxoa tristicula* Morr., which appeared in 1919, was again abundant in the district of Retlaw, Alta.

THE ARMY WORM, *Cirphis unipuncta* Haw. A rather wide infestation of this insect occurred in the province of Nova Scotia. On the whole, the outbreak was not serious, but some fields of oats in which the larvæ were abundant were

cut for fodder. In Yarmouth and Queen's county, N.S., Mr. A. Kelsall, of the Annapolis laboratory, demonstrated the value of poisoned baits for controlling this caterpillar. A bait consisting of sawdust 100 pounds, white arsenic 5 pounds, molasses 2 gallons, gave excellent control. The bait was applied at the rate of 20 pounds to the acre. A report received from Sussex, N.B., indicated that the larvæ were present in large numbers and had caused important injury in fields of oats.

GRASSHOPPERS. These insects were again the cause of much loss in several of the provinces. In Eastern Canada, particularly in the provinces of Ontario and Quebec, and in Western Canada in the three prairie provinces and British Columbia. In the east, the lesser migratory grasshopper, *Melanoplus atlantis* Riley, was especially abundant and caused important injury to clover, corn, timothy and oats. In the province of Manitoba, the infestation in 1920 covered a wider area than that of 1919. The lesser migratory grasshopper and the roadside grasshopper, *Camnula pellucida* Scudd., were the chief injurious species. Mr. Criddle reported that the outbreak of grasshoppers threatened crops over an area of more than ten thousand square miles. This necessitated much publicity work among the farmers during the months of May, June, July and August. It was estimated that the co-operative efforts of provincial and federal entomologists resulted in the saving of crops worth \$17,000,000. Experiments with poisoned baits consisting of sawdust, of any kind, with an equal quantity of bran, were entirely successful and reduced considerably the cost of control. Mr. Criddle further demonstrated the value of salt in the bait as a substitute for molasses and lemons, and excellent control of grasshoppers was secured with a mixture made of 50 pounds of sawdust, 50 pounds of bran and 6 pounds of salt. As a result of these demonstrations large quantities of salt were used by the farmers.

In Saskatchewan, the provincial organization was very effective and according to Mr. M. P. Tullis, Field Crops Commissioner of the province, 1,400,000 acres of crop were actually saved by treatments of poisoned baits. At a grasshopper conference held in Winnipeg in October, 1920, Mr. Tullis made the following statement: "The money value of the crops saved after making all allowances for light yields, destruction by hail, drought, etc., is very great and the figures given reach such a high total, exceeding \$20,000,000, that we hesitate to submit them as the official estimate." Ninety-seven municipalities, or almost one-third of all Saskatchewan municipalities, were infested. The province used 7,200 tons of poisoned bait. In this bait, sawdust was employed to a considerable extent. To the Entomological Branch belongs the credit of first demonstrating under large acreage conditions, the value of sawdust as a cheap carrier for poison.

In Alberta, Mr. E. H. Strickland, directed the grasshopper campaign in 1920. He reported that the area infested south of the main Canadian Pacific Railway line comprised 6,500 square miles, the predominating species being the roadside grasshopper and the lesser migratory grasshopper. As a result of his work, crops to the value of over one million dollars were saved to farmers who followed our recommendations.

The outbreak in British Columbia, in 1920, was reported as serious in sections in the Lower Fraser valley, as for instance in the district of Mission. Reports indicating injury to grass crops were received from North, B.C. The damage by grasshoppers to grasses on cattle range land was investigated by Mr. E. R. Buckell, of the provincial service, under the direction of Mr. Treherne, special studies being undertaken in the Chilootin district, which is a typical range area. Considerable damage was being effected by grasshoppers, particularly the roadside grasshopper.

In order to investigate further the value of various poisons for killing grasshoppers it was arranged for Mr. A. Kelsall (Insecticide Investigations) to spend most of the months of June and July in the neighborhood of Carlyle, Sask. Dust mixtures, contact sprays, poison gas and poisoned baits were experimented with. The dust mixtures, with white arsenic or calcium arsenate as the poisons, were applied in the early morning, at the rate of about 25 pounds to the acre. A traction duster was used to spread the dusts. These experiments indicated that dust mixtures were in no way as successful as the well known poisoned baits. Contact sprays of various kinds were experimented with when the grasshoppers were in a more advanced stage, but the only ones from which results of value were had were either very concentrated kerosene emulsions or pure kerosene. Spraying for grasshoppers under prairie conditions would, of course, be always difficult, particularly owing to the labour required and the difficulty of securing, at hand, the necessary quantity of water. In addition, too, unless in districts where good spraying machines could be regularly used for other purposes, such apparatus would be too expensive to keep for grasshopper years.

The poison gas used was chlorine. The experiments conducted were successful as regards the killing value of the gas, but the cost of the treatment was found to be excessive, being at least \$20 per acre. Mr. Kelsall is of the opinion that when the grasshoppers are in their early stages, it is probable that one treatment with chlorine would accomplish about the same results as three average treatments with poisoned bait. An apparatus was devised (1) "to utilize the gas in such a way as to get the greatest concentration to bear upon the grasshoppers and to prevent waste, and (2) to enable one to operate with gas in the wind. This apparatus, which could be attached to a truck or ordinary wagon, was primarily designed for use on road allowances and headlands, or such places where vegetation would be immaterial." The experiments, on the whole, indicated that, in addition to the danger of injuring crops, the gas treatment was altogether too expensive for practicable purposes.

Experiments with poisoned baits indicated that the most economical insecticide is white arsenic. This, of course, should be superfine, capable of passing through a 200 mesh to the inch screen—if finer, all the better. Various carriers for the poison were used, and further evidence secured of the value of sawdust in these mixtures. Mixtures of one-third shorts and two-thirds sawdust, with five pounds of poison to one hundred pounds of the carrier gave excellent control. A large number of different chemicals, essential oils, fruits, vegetables, etc., were added to the baits, but Mr. Kelsall was unable to obtain any definite well marked benefit from their use. Nothing better was noted than molasses or salt.

THE WESTERN WHEAT STEM SAWFLY, *Cephus cinctus* Nort. This insect was again prevalent in Manitoba and Saskatchewan. Mr. Criddle reported that "the outbreak of 1920 was by far the worst in the history of Western Canada, and the losses due to its attack far exceeded those caused by grasshoppers. It was most plentiful over the southwest portion of the province of Manitoba where, in some places, fully 75 per cent of the wheat stems were cut, and from that area it extended far to the north and east. Generally, it may be said to be present in injurious numbers from the international boundary north 135 miles, and from Saskatchewan east to Portage la Prairie, thus covering an area of approximately 16,000 square miles. The loss by the insect in 1920 certainly amounted to more than a million dollars." Mr. Strickland, in charge of the Lethbridge, Alta., laboratory, reported a slight infestation at Brooks, Alta.

THE BEET WEBWORM, *Loxostege stricticalis* L.—The outbreak of this insect in the prairie provinces continued in 1920, particularly in Alberta. In

the middle of June, Mr. Strickland reported that the moths were present in large numbers. The numbers of moths flying may be realized when it is stated that between June 9 and 20 a single light trap on the entomological laboratory, at Lethbridge, captured an average of 2,000 moths each night. In the latter half of July, the caterpillars were present in countless thousands, especially in the area between Lethbridge and Calgary. In gardens, onions, cabbage, turnips, rhubarb and other plants were freely attacked. In the latter part of July, Mr. Strickland made a trip through the worst infested area. Writing afterwards, he said: "For mile after mile the roadsides were stripped bare of weeds while in many grain fields which had been shockingly weedy, there now projected above the wheat only a forest of bare lambs' quarters stems."

THE EUROPEAN CORN BORER, *Pyrausta nubilalis* Hbn.—This serious pest of corn was first found in Canada on August, 10, 1920. On that day, Messrs. Keenan and Simpson, of the Division of Foreign Pests Suppression, found the caterpillars in a field of ensilage corn near Lorraine Station, Welland county, Ont. Dr. McDunnough, Chief of the Division of Systematic Entomology, confirmed the determination. On August 26, a farmer in the vicinity of Aylmer, Elgin county, Ont., submitted specimens of the larvæ. An investigation of fields in the locality indicated that the infestation was greater than that in Welland county. From early August until towards the end of October scouting work was continued. Mr. McLaine, Chief of the Division of Foreign Pests Suppression, who directed this work, reported as follows: "A total of thirteen counties in northern Ontario were inspected and seven of these were found to be infested by the European corn borer; in all one hundred and five townships were scouted and thirty-five found to be infested." In this scouting work we had the co-operation of the Provincial Department of Agriculture." A further report submitted stated: "The scouting work shows that there are two distinct and more or less widely separated infestations; attempts were made to connect these infestations but without success. Infestation No. 1, centres around Ridgeway and Chrystal Beach, extending along the Lake Erie shore from Fort Erie on the east to Dunnville on the west, and Stevensville on the north. Infestation No. 2 centres around St. Thomas, in Elgin county, extending from Bayham township on the east to Harwich township on the west and to Farquhar, Usborne township, on the north. The total area infested covers approximately two thousand seven hundred and eighty square miles."

A leaflet describing this serious pest was issued in September, 1920, and given wide publicity. The nature of the injury, a description of the borer, the habits of the insect and suggested methods of control were discussed in this leaflet, which also included a full page reproduction of a warning circular which was widely distributed during the spring and summer of 1919 and of 1920 before the borer was discovered in Ontario. It illustrates graphically the life-history of the insect and shows typical damage to the corn plant.

THE POTATO LEAF HOPPER, *Empoasca mali* Le B. In the Niagara district of Ontario, Mr. W. Robinson, under the direction of Mr. Ross, undertook important studies in the life-history and control of this insect. With regard to the latter, these officers reported that Bordeaux mixture alone did not repel the leaf hopper nymphs satisfactorily. When $\frac{3}{8}$ pint of nicotine sulphate (40 per cent) was added to a 3-10-40 Bordeaux, results were secured. "This latter spray was applied most thoroughly to every part of the leaves and within twenty-four hours the tops became entirely free from nymphs of all stages. In order to destroy newly-hatched nymphs, this treatment was repeated in ten days."

In western Ontario, where the insect had been destructive in 1919, no serious outbreaks occurred in 1920, according to reports received from Mr. Hudson, in charge of the Strathroy laboratory.

THE COLORADO POTATO BEETLE, *Leptinotarsa decemlineata* Say. Not nearly so abundant in Eastern Canada in 1920 as in 1919. In the former year it was reported from British Columbia for the first time, having been found in the southeastern corner of the Kootenay district. In 1920, Mr. W. B. Anderson reported the beetle from Waldo, B.C. In Manitoba, Mr. Criddle reported that the insect was exceedingly numerous and occasioned heavy losses to growers, many of whom were not equipped with spraying outfits. Mr. Strickland stated that in southern Alberta the beetle was abundant on wild solanaceous plants, but was not exceptionally severe on potatoes.

THE HESSIAN FLY, *Mayetiola destructor* Say. At the Strathroy, Ont., laboratory, Mr. Hudson continued, in 1920, investigations on the life-history and habits of this insect. In the autumn of 1919, wheat was sown in plots at different dates, in an endeavour to establish safe "fly-free" seeding dates. These preliminary experiments indicated that early sown wheat is likely to be infested to an injurious extent. In plots of wheat sown up to September 18 (Middlesex county), important infestations were noted. Regarding the outbreak of the insect in western Ontario in 1920, Mr. Hudson reported that there were important losses in Elgin, Essex, Kent, Middlesex, and Lambton counties. Further experimental plots of wheat were established in the autumn of 1920. Following a report received indicating the presence of the Hessian fly on Vancouver island, B.C., Mr. R. Glendenning made a survey of the Saanich peninsula in October, 1920, and in nearly every field examined the insect was found to be more or less prevalent. This is the first record we have of the occurrence of the Hessian fly on Vancouver island. Mr. Glendenning was of the opinion that the insect had been present in the Saanich peninsula for several years.

THE IMPORTED ONION MAGGOT, *Hylemyia antiqua* Mg. Further work on the life-history and control of this important pest in British Columbia was continued in 1920, by Mr. Treherne. Much data was obtained on the bionomics of the insect and further experiments conducted demonstrating the value of the trap crop method of control. Mr. Treherne reported as follows: "The cost of applying cull onions as trap crops was slight, only four men for two days in planting and four men for one day in destruction, spread over nine acres. The method shows great promise and local growers are satisfied with the results." It had been previously observed that volunteer plants with leafy growth were preferred by the female flies upon which to deposit their eggs.

THE CABBAGE ROOT MAGGOT, *Hylemyia brassicae* Bouché. Excellent results with corrosive sublimate were again obtained, in 1920, in the control of this insect under field conditions, both in Ontario and British Columbia. In this year many growers in the former province used this remedy for the first time. In sections of the United States, too, it has been adopted as a result of our success. We have estimated that in Ontario alone at least \$50,000 worth of crop was saved. In British Columbia one plantation consisting of 25,000 early Jersey Wakefield cabbages was treated, under the direction of Mr. Treherne, with corrosive sublimate in the strength of one ounce to ten gallons of water (four applications). Perfect control was secured.

OTHER FIELD CROP PESTS. In southwest Manitoba some fields were heavily infested by the greater wheat stem maggot, *Meromyza americana* Fitch, which destroyed the heads just as they were appearing through the sheath. In Ontario, important damage by the same insect was caused in some sections, as for instance in the district of Chatsworth. The western turnip aphid, *Aphis pseudobrassicae* Davis was locally, in Manitoba, responsible for important destruction in fields of white turnips. The cabbage worm, *Pieris rapae* L., and the diamond back moth, *Plutella maculipennis* Curt., were again abundant in

many sections of Canada, causing particular injury to cabbages. White grubs, *Lachnosterna* spp, were complained of in Ontario and Quebec, such crops as strawberries, tomatoes, cabbages and potatoes being attacked. In the same provinces, the ash-grey blister beetle, *Macrobasis unicolor* Kby., attacked the foliage of clover, potato, tomato and beans, particularly during the latter part of June and until about mid-July. The pea moth, *Semasia nigricana* Steph., was reported from Nova Scotia and New Brunswick. In the district of Simcoe, Ont., the pea aphid, *Macrosiphum pisi* Kalt., was again present in destructive numbers.

INSECTS AFFECTING FOREST AND SHADE TREES

The work of the Division of Forest Insects has been under the immediate direction of Dr. J. M. Swaine. Investigations conducted during 1919 and 1920 related to the following important forest and shade tree pests:—

1919

THE SPRUCE BUDWORM, *Harmologa fumiferana* Clem. This insect, better known among foresters and lumbermen as the balsam budworm, was again destructive in some sections in Eastern Canada. Referring to the Quebec province infestation, following personal investigations made by Dr. Swaine and an assistant, Mr. S. A. Graham, it was reported that the heaviest loss to balsam was in the district extending from Grand Lake Victoria eastward to Lake St. John. In this area many dead balsam trees were noted. For instance, around Grand Lake Victoria, between the upper Baskatong country and the upper waters of the Dumoine river, practically all the balsam was found to be dead and many trees had already fallen. The infestation apparently spread from this section eastward and southeastward to Lake St. John, the Saguenay river and into the province of New Brunswick; westward to Lake Abitibi in the province of Ontario. In the province of New Brunswick, according to investigations made by Mr. J. D. Tothill, of the Fredericton, N.B., entomological laboratory and Professor G. H. Prince, Provincial Forester, Dr. Swaine states that "the loss of balsam in trees dead or past recovery in the province as a whole approximates 90 per cent of the stand. A large portion of the New Brunswick forest is predominantly balsam and this enormous loss is a veritable calamity to the provincial pulp industry." In some sections of Eastern Canada, spruce has also suffered to some extent.

BARK-BEETLE INFESTATIONS IN BRITISH COLUMBIA. Following a request from the Chief Forester of British Columbia, Dr. Swaine spent the month of August, 1919, in British Columbia examining particularly bark-beetle infested trees in the yellow pine forests in the Nicola and Kamloops districts. The most serious outbreak was found in the Coldwater, Voght and Spious valleys. Arrangements were made with the Provincial and Dominion Forest Branches to co-operate in winter control work under the immediate direction of Mr. Ralph Hopping, forest entomologist of the Entomological Branch. The injury to the yellow pine is caused by the western pine beetle, *Dendroctonus brevicomis* Lec.

In the district of Yahk, B.C., Dr. Swaine investigated a rapidly spreading outbreak of the western pine bark beetle, *Dendroctonus monticolae* Hopk., which had already killed many of the trees and seriously injured others.

An outbreak of the Douglas fir bark-beetle, *Dendroctonus pseudotsugae*, Hopk., was investigated in the Upper Spious valley, about twelve miles from Canford, B.C. On the north side of the valley, Douglas fir trees in apparently perfect health were found to be severely infested.



Upper figure, adults of the Satin Moth, *Stilpnotia salicis*; lower figure, showing destruction in New Brunswick by Spruce Budworm. (Original).

FOREST SAMPLE PLOT STUDIES. In co-operation with the Commission of Conservation, forest sample plots were established in Quebec province as follows: seven near Lac Tremblant, Que., one on the Bouleé river and five near Lake Edward. Eleven thousand trees, mostly balsam and spruce, were numbered and recorded. Four sample plots were also established in New Brunswick in the district of South Esk. Each of these plots is about an acre in size. From the information gained from these plots, we expect eventually to have exact knowledge of the various factors which determine the development of new timber. Mr. M. B. Dunn, of the Division of Forest Insects, has been in immediate charge of this work.

THE LARCH SAWFLY, *Nematus erichsonii* Hartig. Dr. Swaine reported serious and extensive injury to larch by this insect, west of the Great Lakes in northern Ontario and Manitoba. Defoliation was noticeable along the lines of both the Canadian Pacific Railway and the Canadian Northern Railway west of Fort William, Ont. Many trees were dead and large numbers apparently dying.

FOREST INSECT INJURY IN JASPER PARK, ALTA. At the request of the Commissioner of Dominion Parks, arrangements were made for Dr. Swaine to personally investigate reports of the dying of lodge-pole pine in the Jasper National Park. In August, 1919, therefore, a survey of certain sections of the park was made and it was found that, in places, the pine was seriously diseased. The trees showed characteristic evidence of mistletoe attack, the larger pine in some stands being from 10 to 25 per cent dead or very badly diseased.

SHADE TREE INSECT STUDIES. Mr. C. B. Hutchings, of the Division of Forest Insects, continued investigations on the biology of certain shade tree pests, particularly the oak carpenter worm, *Prionoxystus macmurtrei* Guer., a rather uncommon pest and one that has been little studied; and the bronze birch borer, *Agrilus anxius* Gory, an important pest, the eggs of which were found after three seasons' search. These investigations were conducted at the forest insect laboratory at Aylmer, Que., and at the insectary, Central Experimental Farm, Ottawa. In 1919, Mr. R. N. Chrystal, of the same division, made a study of the biology and control of the European elm sawfly leaf-miner, *Kaliosyphinga ulmi* Sund., which had become established in the district of Kingston, Ont.

In the *Agricultural Gazette of Canada*, Vol. 6, No. 2, Mr. W. B. Anderson recorded an outbreak of the tussock moth, *Hemerocampa vetusta gulosa*, and a reference to the infestation is also given in the late Dr. Hewitt's report as Dominion Entomologist for the years 1917 and 1918. Further breeding and study of this insect has resulted in the conclusion that the identification was in error and since, Dr. McDunnough has described it as a new species, *Hemerocampa pseudotsugata*.*

1920

THE SPRUCE BUDWORM, *Harmolopa fumiferana* Clem. Investigations conducted by officers of the Division of Forest Insects in 1920 indicated that this insect had spread considerably. Dr. Swaine reported as follows: "The budworm outbreak has spread from the Grand Lake Victoria country through Lake Expance and Long Lake, across the Temiskaming and Northern Ontario railway into the Timagami forest reserve. It extends south and along Lake Temiskaming northward across the height of land." In order to secure further information as to the extent of this infestation, arrangements were made with the Air Board for aerial flights over budworm-attacked forests. In these flights our

* Canadian Entomologist, LIII, 53, 1921.

officers were accompanied by foresters attached to the Commission of Conservation. Dr. Swaine and Mr. Dunn, undertook this work. The former in reporting upon these flights states: "We were able to obtain valuable information upon the area of the infestation and also to locate the blocks of spruce and balsam which could be expected to suffer from attack next season. Our flights covered the area west and north of Lake Temiskaming where the outbreak was spreading and also west and northeast of the lakes in which areas the infestation has been acute for the last two years. From a height of 3,500 feet it was possible to determine the different types of timber and to locate the blocks of spruce and balsam accurately. The information obtained from a few days' flying would have taken two men more than six months to acquire by ground surveys." No other reports of active budworm infestation in any other parts of Ontario or in Quebec province were received in 1920. In New Brunswick, in 1920, under the direction of Mr. J. D. Tothill, a survey of forested areas in the province was undertaken. As a result of this survey it was found that the injured area was largely confined to the central part of New Brunswick, balsam having been especially attacked.

BARK-BEETLE CONTROL OPERATIONS IN BRITISH COLUMBIA. Following a co-operative arrangement between the Dominion Forestry Branch, the British Columbia Forestry Branch, the Dominion Department of Indian Affairs, local lumber companies and the Entomological Branch, Mr. Ralph Hopping planned and supervised all control work to check the spread of the bark-beetle outbreaks in yellow pine in the Coldwater, Voght, Indian Meadows, and Spious valleys. Dr. Swaine reported on this work as follows: "The entire work was apparently performed in a most thorough manner. In addition to the regular logging operations, including special slash burning regulations, more than 6,000 infested trees were cut and burned in the direct control work. The area covered by the direct control work would, without question, have shown thousands of freshly infested trees this season if the work had not been done. Our inspection showed only a very small number of freshly infested trees, at most one or two hundred over the whole area of many square miles."

FOREST SAMPLE PLOT STUDIES. A number of additional acre forest sample plots were established by Mr. Dunn in 1920, as follows: one in mixed spruce pine and hardwoods near the shore of Lake Abitibi, Que.; two in spruce and balsam near Long Lake, Que.; three in spruce and jack pine near Harcourt, N.B.; three in spruce and balsam near Bathurst, N.B.; and two in spruce and balsam near Fredericton, N.B. The trees on all of these plots were numbered and recorded as in 1919.

SHADE TREE INSECTS. Few reports of important injury to shade trees were received during 1920. An infestation of the satin moth of Europe, *Stilpnotia salicis* L., on poplar trees was discovered in July of this year in the city of New Westminster, B.C., by our officers, Messrs. Tothill and Baird. The caterpillars were not abundant enough to cause much damage. This insect is a pest of importance in Europe and Asia, and in addition to poplar trees, it also attacks willows.

At the forest insect laboratory at Alymer, Que., Mr. Hutchings made further observations on the life-history and control of the oak carpenter worm, *Prionoxystus macmurtrei* Guer. A study of the birch-leaf skeletonizer, *Bucculatrix canadensisella* Chamb; which was prevalent in eastern Canada, was also made, and notes taken on other insects of importance. The fall canker-worm, *Alsophila pometaria* Harr., was also prevalent in Eastern Canada; in some districts the caterpillars entirely denuded maple, ash and elm trees.

INSECTS AFFECTING FRUIT CROPS

Studies of the life-histories and habits of important orchard insects and their control were made in 1919 and 1920 in the following provinces:—

NOVA SCOTIA. In this province investigations related almost entirely to insecticides, special mention of which work is made on page 25. The most important record of the year 1919 was the discovery of the apple sucker, *Psyllia mali* Schmidb., an European insect found for the first time in North America, at Wolfville, N.S. In reporting upon this discovery, Professor W. H. Brittain*, Provincial Entomologist for Nova Scotia, stated as follows: "It is a notable fact that this outbreak should take place so suddenly and in such great severity in a district where its presence was never before noticed, neither by the owners of the orchard nor by any members of the provincial inspection staff working in that district. During the summers of 1912, 1913 and 1914, all this territory was carefully covered by provincial inspectors during the San Jose scale survey, and if this insect had been present in destructive numbers, it could hardly have failed to attract their notice. Subsequent to that date, the department had been conducting extensive spraying and dusting experiments in the vicinity of Wolfville, and an outbreak of this kind would certainly have been observed or reported, had such occurred. We are, therefore, safe in saying that this is the first destructive outbreak that has taken place in Nova Scotia, as well as the first record of the occurrence of this insect in North America. It goes without saying, however, that before the infestation could reach such proportions, the insect must have been present for some time."

THE WHITE-MARKED TUSSOCK MOTH, *Hemerocampa leucostigma* Sm. and Ab., which was prevalent in 1917 and 1918, was practically absent throughout the Annapolis valley in 1919 and 1920. Both of the tent caterpillars, *Malacosoma americana* Fab., and *M. disstria* Hbn., were noticed in apple orchards but not excessively. The pear psyllia, *Psyllia pyricola* Fuerst, was reported in numbers on apple, pear and plum, particularly in Kings county. The green apple bug, *Lygus communis novascotiensis* Knight, while present in destructive numbers in some orchards, was noticeably absent in others. The oyster-shell scale, *Lepidosaphes ulmi* L., was very numerous in 1919, and in the same year the apple leaf-miner, *Tischeria malifoliella* Clem., was particularly abundant. Two other pests which were present in destructive numbers were the blister mite, *Eriophyes pyri* Pgst., very numerous on apple; and the common spider mite, *Tetranychus telarius* L., which was reported by Mr. Sanders as causing serious damage to apple trees in several localities, the first time he had observed such serious attack.

QUEBEC. Experiments with various orchard mixtures were continued by Mr. Petch, in charge of the Hemmingford laboratory, much valuable data resulting therefrom. As a result of his work on spray mixtures, Mr. Petch is recommending for use in Quebec, lime-sulphur sprays in the following strengths: green-tip spray, 1.010 sp. gr.; pink-bud spray, 1.008 sp. gr.; calyx spray, 1.007 sp. gr.; after calyx spray, 1.007 sp. gr.; all later sprays, 1.006 sp. gr., with arsenate of lime added in each case at the rate of $\frac{3}{4}$ pound to 40 gallons of mixture.

In 1919 and 1920, the apple curculio, *Anthonomus quadrigibbus* Say, and the plum curculio, *Conotrachelus nemophar* Herbst, particularly the latter, were responsible for serious injury resulting in thousands of barrels of apples being unsaleable. In both years, too, the apple maggot, *Rhagoletis pomonella* Walsh, was increasingly destructive and destroyed entirely what otherwise would have been an excellent crop of fruit. The red-humped apple caterpillar, *Schizura concinna* Sm. and Ab., caused considerable damage to trees in a number of dis-

* Agric. Gazette Can., Sept., 1919, p. 824.

tricts, but was not so destructive as in 1918. The fall webworm, *Hyphantria cunea* Drury, was noticeably present in the province. In some sections, the budmoth, *Tmetocera ocellana* D. and S., and the cigar case bearer, *Coleophora fetcherella* Fern., effected important injury to apples, particularly in the Chateauguay, Hemmingford, Rougemont, and Abbotsford districts. The codling moth, *Carpocapsa pomonella* L., was observed in increased numbers in many orchards.

ONTARIO. Under the immediate direction of Mr. W. A. Ross, life-history studies of the pear psyllia, begun in 1917, were continued in 1919 and 1920 and much further work was effected on the control of this insect, valuable data being secured, especially in regard to the susceptibility of the eggs to various spray materials. In the same year, investigations on the strawberry weevil, *Anthonomus signatus* Say, were undertaken and excellent progress reported. Experiments with insecticides for controlling various species of aphids and other fruit insects were conducted in 1919 and 1920. An investigation of the blackberry leaf miner, *Matalbus bethunei* MacG., was incepted in 1919. The codling moth was more abundant than usual in 1919 and was responsible for considerable loss. Some unsprayed orchards in the Niagara district had almost every apple infested, while orchards which had been well sprayed for several years suffered little injury, thus showing the cumulative effects of good spraying. The mullein leaf-bug, *Campylomma verbasci* Mey., which attacks a variety of plants, was reported by Mr. Ross as being abundant in apple orchards in Norfolk county. Baldwin, Roxbury Russet, and Spy varieties were freely attacked, on some infested trees 75 per cent of the apples being more or less injured. Conspicuous brown or blackish corky warts formed at the spots where punctures by the nymphs were made.

Other orchard pests which were destructive in Ontario in 1919 were: the cigar case bearer, the work of which was readily apparent in unsprayed orchards; the blister mite, which increased to a marked extent; the pear slug, *Caliroa cerasi* L., which destroyed the foliage of thousands of pear and cherry trees; the rose chafer, *Macrodactylus subspinosus* Fab., which appeared in countless numbers, as for instance in the Simcoe and Fonthill districts, and injured apples, grapes and cherries; the plum curculio, unusually destructive in the Niagara district, in one peach orchard over 50 per cent of the crop being destroyed; the blackberry leaf-miner, which caused important injury in blackberry plantations in the Burlington and Niagara districts; the rose leaf hopper, *Typhlocyba rosae* L., common on foliage of apples; and the budmoth, which was more abundant than usual.

In 1920, Mr. Ross made a preliminary investigation of the status of the plum spider mite, *Paratetranychus pilosus* Can. and Fanz., as a pest in the Niagara district. It had been observed that plum trees which were not sprayed or which were sprayed with Bordeaux mixture, became heavily infested with the mite. Mr. Ross stated as follows: "On badly infested trees the mite by its feeding activities made the foliage pallid and sickly in appearance and apparently functionless. In our two experimental orchards, the difference between the infested rows of trees with their pallid foliage (sprayed with Bordeaux mixture) and the uninfested trees with their dark green foliage (sprayed with lime sulphur) was very striking and could be observed a long way off."

Most of the imported pests prevalent in 1919 were again complained of in 1920. In addition, in this latter year, outbreaks of the following insects were specially reported by Mr. Ross: the San Jose scale, *Aspidiotus perniciosus* Comst., which is increasing in unsprayed and poorly sprayed orchards; the oyster-shell scale, more noticeable than during the previous two or three years; the fruit tree leaf roller, *Cacoecia argyrospila* Wlk., found in destructive numbers, particularly in the vicinity of Newcastle; the fall canker worm, *Alsophila*

pomictaria Harr., especially noticeable in Halton and Wentworth counties where some trees were completely defoliated; and the grape leaf hopper, *Erythroneura comes* Say, which was present in injurious numbers in several Niagara vineyards.

BRITISH COLUMBIA. In this province, Mr. Treherne directed investigations relating to the following insects.

THE PEACH TWIG BORER, *Anarsia lineatella* Zell.—Further studies on the life-history, habits and control of this insect were made in 1919, particularly in the district of Penticton. It was again demonstrated that applications of lime-sulphur and arsenate of lead successfully controlled this insect.

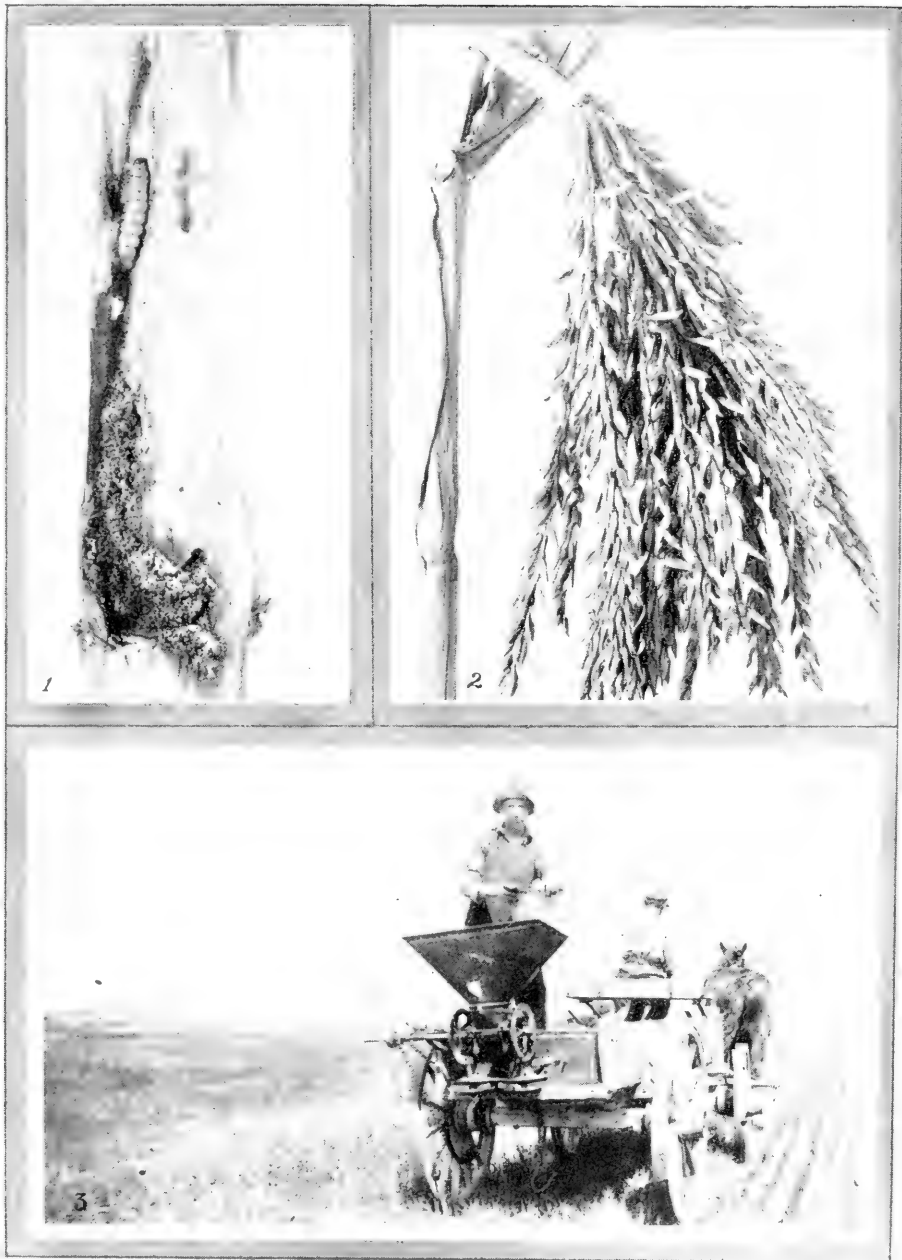
FRUIT WORM INVESTIGATIONS.—In reporting upon these studies, Mr. Treherne stated as follows: "For many years the correct identity of the various fruit worms and budmoths infesting Okanagan apple orchards has been in doubt because of the superficial resemblance of the fruit worms and the possible confusion with the larvæ of the codling moth, which latter insect has not as yet become generally established in the Okanagan valley. In some years severe injury is caused to the buds and fruit of apple trees. Larval feeding and structural characteristics have been studied this year (1919) of the following: *Tmctocera ocellana* D & S., *Argyroplote consanguinana* Wlsm., *Cacoecia rosaceana* Harr., *Mineola tricolorella* Grt., and *Laspeyresia prunivora* Walsh.

THE CODLING MOTH. During 1919, provincial inspectors found 257 larvæ and pupæ of this insect which were collected in the area under quarantine at Okanagan Landing; in addition, 116 were collected in the district comprising the city of Vernon. In 1920, the findings in the former district were 89; in the latter careful inspection throughout the season in this year failed to reveal the presence of any larvæ or pupæ. A new infestation, however, of an important nature was discovered in 1920, namely in the region of Swan lake, three miles north of the city of Vernon.

Experiments in superheating empty railway cars to prevent the introduction of injurious fruit insects, such as the codling moth, were begun in 1920. Following recommendations from our own and provincial officers, arrangements were made to conduct preliminary experiments at Okanagan Landing, B.C., with the co-operation of the Canadian Pacific Railway. Several insects of various stages were placed in the cars and Mr. Treherne reported that steam injected into a refrigerator car under 60 pounds pressure raised the temperature in fifteen minutes to 115° F., resulting in the death of all insects used in the experiments.

THE STRAWBERRY ROOT WEEVIL, *Otiiorhynchus ovatus* L. The investigation of this insect on the Saanich peninsula of Vancouver island, commenced in 1918, was continued in 1919 and 1920 by Mr. Downes. Satisfactory progress was made in devising barriers to prevent the weevil gaining access to strawberry plantations. This work, which was conducted principally at Gordon Head, B.C., will be continued in co-operation with the Provincial Horticultural Branch of the Provincial Department of Agriculture.

THE CURRANT FRUIT FLY, *Epochra canadensis* Loew. In the Vernon district, Mr. Treherne reported that the flies were abundant on May 19, and many eggs were present in the fruit on May 22. "This was at a period in the growth of red currants when some fruit had commenced to form but with some blossoms still in evidence. Red currants were in full bloom during the first two weeks of May. Maggots started to leave the fruit for pupation at the end of June, entering the soil to a depth of from 1 to 4 inches." Control experiments with poisoned bait sprays conducted in the Okanagan valley by Mr. Treherne, and



Figures 1 and 2 showing work of European Corn Borer; Fig. 3. Distributing poisoned bait for grasshoppers, in Manitoba. (Original).

on Vancouver island by Mr. Downes, were not promising in nature and our officers preferred to recommend cultivation and the use of chickens, which should be allowed to run among the bushes so that they may feed upon the prematurely ripened fallen fruit and the larvae which may have left the fruit and entered the earth. Owing to the fact that chickens are liable to disturb the soil to a considerable extent at times, care should be taken to prevent the root system remaining bare for too great a length of time, especially in arid sections.

Other insects of importance which occupied the attention of our officers in British Columbia were: the raspberry crown borer, *Bembecia marginata* Harris, an investigation of which was started on Vancouver island in 1919; the rose leaf-hopper, *Empoa rosae* L., which was abundant in many apple orchards in the Okanagan valley, particularly in 1919; the western lined June beetle, *Polyphylla decemlineata* Say, which in some years is present in destructive numbers, and which in 1920 caused important losses on Vancouver island in fields of strawberries; and the raspberry cane maggot, *Phorbia rubivora* Coq., the attacks of which in 1920 were confined largely to loganberries.

INSECTS AFFECTING GREENHOUSE AND ORNAMENTAL PLANTS

THE ROSE MIDGE, *Dasynewa rhodophaga* Coq. This insect during recent years, particularly in 1919, caused very serious losses to roses grown under glass in the province of Ontario. Following investigations conducted chiefly by Mr. Ross, of the Vineland Station, Ont., laboratory, we were able to demonstrate the value of tobacco dust as a remedy for this pest and during 1920, important growers whose premises were infested followed our recommendations with perfect success. Tons of tobacco dust were used by Ontario rose growers, which dust was obtained through the efforts of our officers who found a sufficient source of supply and arranged for its distribution. The results of these investigations in 1920 were, it was estimated, worth at least \$50,000 to the growers.

THE GREENHOUSE LEAF-TYER, *Phlyctacnia ferrugalis* Hbn. This insect has become a major pest in greenhouses, particularly in Eastern Canada. It has been particularly destructive to the foliage of chrysanthemum, cineraria, marigold, ageratum, primula, and snap dragon. Following control experiments conducted during the winter of 1918-19, the following spray mixture is recommended: soluble sulphur, one ounce by weight; nicotine sulphate (40 per cent) one fluid ounce; and water, six gallons. Three applications, at intervals of one week, have controlled the pest.

THE GREENHOUSE WHITE FLY, *Trialeurodes vaporariorum* West., was frequently complained of in 1919 and 1920, from various districts of Eastern Canada, particularly in Ontario, the plants attacked being tomato, cucumber, aster, primula, fuschia, lobelia, etc.

Other pests complained of were the chrysanthemum midge, *Diarthronomyia hypogaea* H.Lw.; the variegated cutworm, *Lycophotia margaritosa* Haw; the chrysanthemum leaf-miner, *Phytomyza chrysanthemi* Kowarz; the cabbage looper, *Autographa brassicae* Riley; the cyclamen mite, *Tarsonemus pallidus* Banks; and such regularly occurring enemies of greenhouse plants, as the common scale insects, mealy bugs and aphids.

INSECTS AFFECTING MAN AND DOMESTIC ANIMALS

MOSQUITO INVESTIGATIONS. In 1919, a preliminary investigation of the economic importance of mosquitoes in the Fraser River valley of British Columbia was undertaken by Mr. E. Hearle. Life-history studies were made of the various kinds of mosquitoes inhabiting the region investigated. In this

work four main objects were kept in mind, namely (1) a general study of the topography and nature of the district; (2) the economic relation of mosquitoes to the industries of the affected area; (3) a study of the factors governing mosquito abundance; and (4) a study of the mosquito fauna to ascertain the important species and locate their breeding places. A laboratory was established at Mission, B.C.

The following is a brief summary of Mr. Hearle's work in 1920: The Mission laboratory was mainly restricted to a careful study of the main problems, which had been determined by the 1919 faunal survey. By means of motor-boat and canoe the main breeding areas, flooded alder bottoms and open prairies bordering the Fraser river, were worked over and the mosquito breeding conditions in these places were made the subject of careful investigation. No season could have offered better advantages for this work as the river freshets were higher than they had been for many years. The comparison of conditions in 1919 and 1920 is of very great value in determining those factors responsible for mosquito outbreaks in the district. In 1919 mosquitoes were not sufficiently abundant in the valley to constitute a pest or to be considered as a factor of economic importance. During 1920, the mosquito plague was, next to the actual loss of crop by flooding, the most vital economic factor affecting the lower Fraser valley. Nearly all the lumber camps in the affected district were closed down for varying periods, construction of roads were hampered and general farming operations were seriously handicapped. The marked difference in the mosquito conditions of 1919 and 1920 resulted from the difference in the freshet levels. In 1919 seventeen feet four inches was the highest level reached, and in 1920 the river rose to twenty-one feet and very extensive areas were flooded. Although field surveys occupied most of the time a certain amount of laboratory and experimental work was undertaken and methods for breeding and carrying out life-history studies were devised. The season proved to be a highly satisfactory one in that it enabled a careful study to be made of the mosquito pest at its worst.

LIVE STOCK INSECTS. In the province of Saskatchewan, Dr. Cameron continued, as time permitted, studies of the insect pests of cattle. In 1919, some progress was made in the study of black flies, which in some years are very troublesome. Dr. Cameron reported in part as follows: "The prevalent species is *Simulium simile* Mall., recently described from the arctic. Breeding as it does, extensively in the North and South Saskatchewan rivers, the areas most affected are adjacent to their places of origin. Large swarms may, however, be encountered as far as twenty miles from the rivers, and wherever they occur in numbers, the cattle suffer considerably from their biting."

In Quebec province, Mr. Petch made further observations on warble flies, reporting that they were abundant, causing much annoyance to cattle. In Manitoba, Mr. Criddle reported that in 1920, the horn fly, *Hæmatobia serrata* R-D, was very numerous, in fact more so than any season since its first introduction. Other live stock pests, such as horse flies, bot-flies and warble flies were also complained of in the prairie provinces.

INSECTICIDES

Important progress has been made in the development of improved insecticides, such research being conducted at the Annapolis Royal, N.S., laboratory under the immediate direction of Mr. G. E. Sanders with the assistance of Mr. A. Kelsall.

These researches were, for the most part, of a comprehensive nature involving chemical studies of the insecticides under consideration, insectary

studies on the effect of insect poisons, and experimental field plots both large and small. As a result spray calendars and dust calendars were devised, relating to various plant crops in various localities, embodying the latest findings on the subject, and thus making such information readily available to the public.

One of the important results of this work was the development and advancement of the dust method of pest control. It was shown that under certain conditions the dust method could be efficiently and economically utilized. This desirable achievement was in part brought about by studies of several factors pertaining to this problem, namely, the development of new dusting materials, the development of new manufacturing and dust mixing systems which were capable of turning out much cheaper products, the development of more efficient dusting machines, and a study of the periods and timing of dust applications which would give maximum results. In all these a considerable degree of success was obtained. The dust invented by Mr. Sanders composed of dehydrated copper sulphate, calcium arsenate, and hydrated lime came rapidly into general use, not only in Canada but throughout the United States and also in other countries. Coincidentally better types of power dusters were manufactured, and each year brought a price reduction of the materials used due to more up-to-date methods of making and distribution, and to the larger scale on which such materials were being handled.

Methods were developed for the utilization of white arsenic as an insecticide in Bordeaux mixture. White arsenic being much the cheapest form in which arsenic can be obtained, this method was one which represented a high potential saving, particularly for potato growers. This method has already been utilized to some extent by growers, but in its present form the making of the mixture involves a little extra inconvenience, and for this reason studies are being continued on this problem with very high hopes of a satisfactory solution.

Other numerous lines of investigation have received attention, the compatibility of various insecticides with various fungicides, foliage injuries resulting from sprays and dusts, their cause and prevention, insect repellents and attractants, new uses for insecticides, relative tests and efficiency of new insecticides, and so on. The manufacture of new insecticide-fungicide dusts has occupied much time and thought, and investigations are at present under way on the manufacture of dusting materials which will be much cheaper, for a given amount of efficiency, than dusts at present in use. These have at present reached a stage where at least some measure of success would appear assured.

More recently other new lines of work have been commenced. Among the more prominent of these may be mentioned the utilization of nicotine fumes and other gases as insecticides in connection with a power-dusting machine, a study of various spray and dust "spreaders" and "stickers," and a study of the absorption of water soluble arsenic by various materials.

Insecticide specifications and standardization have necessarily received much study. The desirable percentages of active ingredients, the maximum percentage allowable of water soluble arsenic, the fineness, etc., are all important. In all of these matters the services of our insecticide entomologists have been much in demand.

THE NATURAL CONTROL OF INSECTS

Studies of the natural control of certain important insect pests were continued during the two years covered by this report along similar lines as during the years preceding. These studies were under the immediate charge of Mr. J. D. Tothill, assisted particularly by Messrs. A. B. Baird, A. G. Dustan, and R. P. Gorham.

THE SPRUCE BUDWORM, *Harmologa fumiferana* Clem. Much additional data was obtained on the natural control of this forest insect which has caused enormous losses in Eastern Canada. In addition to studies made in New Brunswick in 1919, Mr. Baird made observations in British Columbia in the same year. In the following year, Mr. Dustan continued a study of the parasites attacking the budworm in the vicinity of Fredericton, N.B.; about 60 per cent of the larvæ in this latter district were found to be parasitized. In 1920, Mr. Tothill spent about a month in British Columbia, particularly in the Lillooet district, where he made special observations relating to the effect of winds in connection with the distribution of the insect. In the same district, Mr. Baird continued parasite studies and observations were also made on the birds present which were seen to be feeding to an important degree upon the budworms.

THE FALL WEBWORM, *Hyphantria cunea* Drury. The studies of the natural control of this insect, which have been conducted for a number of years by Mr. Tothill, are now completed and have been published in bulletin form.*

THE FOREST TENT CATERPILLAR, *Malacosoma disstria* Hbn. The causes of outbreaks of this insect have been specially studied by our officers. In 1920, investigations related particularly to the province of British Columbia. Mr. Tothill reporting on the outbreak in the district of Vancouver and New Westminster, stated: "From the studies that Mr. Baird has made it is evident that the first cause of the outbreak is an overproduction of food supply, due to the march of civilization. In the thirty or forty square miles of suburban territory affected, the original forest cover has been removed and a thick second growth of willows and alders has taken its place. This has afforded an admirable feeding ground for the insects in question. Coupled with the abundance of food, there is also an overproduction of domestic cats and a consequent underproduction of insectivorous birds, such as are found generally in suburban districts; so that the insects have had an unusually good opportunity for an outbreak. Another thing that has worked to the advantage of the caterpillars is that during the outbreak, insect parasites have been an almost negligible factor in control."

Minor projects undertaken related to the following:—

THE WHITE-MARKED TUSSOCK MOTH, *Hemerocampa leucostigma* S and A. A two-year study of the natural control of this insect was completed by Mr. Dustan. An account of this work has been published in the Proceedings of the Acadian Entomological Society.†

THE OYSTER SHELL SCALE, *Lepidosaphes ulmi* L. In 1917 colonies of the predaceous mite, *Hemisarcoptes malus* Shimer, collected in New Brunswick were forwarded to British Columbia and liberated on Vancouver island, at Mission, and in the Okanagan valley. Examinations made in the latter district, in 1920, by Mr. Baird, showed that the mite had become established with every promise of increasing and rendering useful service.

THE GREEN APPLE BUG, *Lygus communis novascotiensis* Knight. A study of the natural control of this insect in Nova Scotia was undertaken in 1920, Mr. Dustan being detailed for the same, which was incepted in the immediate vicinity of Wolfville. Mr. Dustan found that an important control factor, namely, a fungous disease of the genus *Entomophthora*, was responsible for the destruction of large numbers of the adults of the insect.

PARASITE RECOVERIES. Work in connection with the recovery of parasites of the brown tail moth liberated in the Maritime Provinces during the summers of 1913 to 1916 was continued. Mr. Tothill reported that the tachinid

* Bull. No. 3, N.S., Dom. Dept. Agric., 1922.

† No. 8, 1922.

parasite, *Compsilura concinnata* Meigen, was found in the Annapolis valley, it having been recovered in New Brunswick in the summer of 1918. It is very gratifying indeed to report that this important parasite is now apparently established in both of the above provinces.

The hymenopterous parasite, *Apanteles lacteicolor* Vier., of the brown tail moth, was reported by Mr. W. N. Keenan to have been recovered in 1920 from three localities in Nova Scotia, namely, Lochartville and Horton in Kings county, and Round Hill in Annapolis county. In this province in this year there was a marked decrease in the number of winter webs collected and as a result only a small number of the webs were collected for *Apanteles* recovery purposes.

II—THE ADMINISTRATION OF THE REGULATIONS UNDER THE DESTRUCTIVE INSECT AND PEST ACT.

In the reorganization of the entomological service, a new division was established in April, 1919, namely, the Division of Foreign Pests Suppression, and Mr. L. S. McLaine was appointed to the position of chief of the division. This division is concerned with the carrying out of the regulations under the Destructive Insect and Pest Act, so far as these refer to insects.

INSPECTION AND FUMIGATION OF FOREIGN NURSERY STOCK AND OTHER PLANT PRODUCTS

During the importing seasons of 1918-1919, and 1919-1920, the inspection and fumigation of nursery stock and other plant products was continued as formerly. Numerous specimens of scale insects, aphids, lepidoptera, beetles, and other foreign insects were intercepted and removed from stock. Owing to the great difficulties of overseas transportation during these years, as well as the increased cost of freight rates and other factors which affected trade, there was a decided reduction in the quantity of nursery stock entering Canada from Europe.

Mr. McLaine has prepared the following tables which relate to the seasons of 1918-19 and 1919-20, respectively.

IMPORTATION OF NURSERY STOCK SUBJECT TO INSPECTION, SHOWING COUNTRIES OF ORIGIN, SEASON 1918-1

Nature of Stock	Holland	France	Great Britain	United States	Japan	Totals
Ornamentals.....	43,524	241,584	51,118	21,817	198	358,241
Conifers.....	4,220	85,695	5,439	.....	43	95,397
Fruit trees.....	42	50	45	16,195	4	16,336
Small fruits.....	216	.....	39	1,910	.....	2,165
Seedlings and grafting stock.....	.....	310,000	87,927	6,400	.....	404,327
	48,002	637,329	144,568	46,322	245	876,466

IMPORTATIONS OF NURSERY STOCK SUBJECT TO INSPECTION, SHOWING DESTINATIONS OF SHIPMENTS, SEASON 1918-19

Nature of Stock	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	British Columbia	Totals
Ornamentals.....	125	28,603	1,460	40,844	287,003	2	204	358,241
Conifers.....		10		415	94,972			95,397
Fruit trees.....		3,798		205	12,311		22	16,336
Small fruits.....		2,038		20	107			2,165
Seedlings and grafting stock.....		5,400			398,815		112	404,327
	125	39,849	1,460	41,484	793,208	2	338	876,466

IMPORTATIONS OF NURSERY STOCK SUBJECT TO INSPECTION, SHOWING COUNTRIES OF ORIGIN, SEASON 1919-20

	Holland	Belgium	France	Great Britain	United States	Japan	Denmark	Totals
Ornamentals.....	178,217	13,865	375,250	20,846	20,964	10,884	9,550	629,616
Conifers and evergreens.....	22,046	16	64,475	596		323		87,456
Fruit trees.....	167		15,075	411	3,836	10		19,499
Small fruits.....			1,270	11	1,284			2,565
Seedlings and grafting stock.....	36,700		283,035	84,590		1,000		405,325
	237,130	13,881	739,145	106,454	26,084	12,217	9,550	1,144,461

IMPORTATION OF NURSERY STOCK SUBJECT TO INSPECTION, SHOWING DESTINATION OF SHIPMENTS, SEASON 1919-20

	Nova Scotia	New Brunswick	Quebec	Ontario	British Columbia	Prince Edward Island	Totals
Ornamentals.....	26,396	12,565	36,322	528,591	25,619	123	629,616
Conifers and evergreens.....			7,606	72,850			87,456
Fruit trees.....	2,778			16,695	26		19,499
Small fruits.....	1,173			1,279	113		2,565
Seedlings and grafting stock.....	6,275			325,860	73,190		405,325
	36,622	12,565	43,928	952,275	98,948	123	1,144,461

FIELD WORK AGAINST THE BROWN-TAIL MOTH

The winter field work against this insect was continued in 1918-19 and 1920-21 in the provinces of New Brunswick and Nova Scotia under the supervision of Mr. McLaine.

NEW BRUNSWICK

The counties of Carleton, York, Sunbury, Queens, and Charlotte were scouted in the winter of 1918-19, and it is gratifying to state that not a single winter web of the brown-tail moth was found. Nests in all of these counties had been found during the previous winter. In the winter of 1919-20, the same counties were again scouted, attention being directed particularly to the areas most likely to be infested by the pest. During this period, too, no nests were found. Mr. McLaine, in reporting upon this work, stated:—

“The brown-tail moth work has gradually been reduced to its present status chiefly by careful and consistent work on the part of the scouts employed. It will be remembered that during the winter of 1913-14, as many as 28,100

winter nests were collected. The insect undoubtedly develops under New Brunswick conditions; it is, therefore, advisable to scout areas which appear to be favourable breeding grounds. Our recent policy has been to reduce the cost of the work to as low a minimum as possible, but always to be on the watch for a new outbreak."

In the winter of 1918-19, the province of New Brunswick co-operated with the Entomological Branch by furnishing additional inspectors, but in 1919-20, owing to the fact that no winter webs were being found by our own inspectors, this additional help was not necessary. Mr. W. N. Keenan, of the Division of Foreign Pests Suppression, had the immediate direction of this work.

NOVA SCOTIA

In the province of Nova Scotia scouting work of a similar nature to that in New Brunswick was conducted. In 1918-19, the field work started on November 19, 1918, and was completed by April 5, 1919.

During this period an average of ten scouts were employed; five by the province and five by the Entomological Branch, all under our direction. Mr. McLaine reported that in 1918-19, 1,269 winter nests were collected, as compared with 3,024 found in 1917-18, representing a decrease of approximately 50 per cent. Four counties were found to be infested, namely, Digby, in which three webs were found; Annapolis, in which 655 webs were found; Kings, in which 602 webs were found. Ninety-one per cent of the webs were taken from apple trees. The total number of localities found infested was 54, as compared with 92 in 1917-18.

In the winter of 1919-20, field work was started on December 1, 1919, and was completed on March 13, 1920. Mr. McLaine reporting on the result of this season's work, stated: "At the beginning of the season ten scouts were employed, but on account of the rapidity with which the ground was covered, favourable meteorological conditions, and the fact that few nests were being found, six of the scouts were discharged on January 31, 1920. The total number of nests found during 1919-20 was 358, as compared with 1,269 in 1918-19, a decrease of about 72 per cent. In Annapolis county, 97 nests were found, in Kings county 260, and in Hants county 1." In 1919-20 as previously, the work was undertaken jointly by the Provincial and Federal Departments. The total number of localities found infested in 1919-20 was 22, as compared with 54 in 1918-19. On apple trees there were 331 nests found.

Mr. F. C. Gilliatt, of the Annapolis laboratory, was in charge of the Nova Scotia field-scouting parties.

AMENDMENTS TO REGULATIONS 1919

By Order in Council dated May 19, 1919, the importation into Canada was prohibited of all corn fodder, or cornstalks, whether used for packing or otherwise, green sweet corn, roasting ears, corn on the cob or corn cobs, from the counties of Essex, Middlesex, Norfolk, and Suffolk, in the state of Massachusetts, and also from the counties of Schenectady, Saratoga, Montgomery, and Albany, in the state of New York, two of the United States of America. This prohibition shall not extend to shipments of corn transported through the quarantined areas on a through bill of lading. This amendment was passed owing to the danger of introducing into Canada with such importations, the very destructive European corn borer, *Pyrausta nubilalis* Hbn., which has become established in the states mentioned.

By Order in Council dated November 28, 1919, no apple stock of any description, including nursery stock seedlings, scions, buds and grafts, shall be removed from that area included within a radius of five miles of the post office of the town of Wolfville, in the county of Kings, province of Nova Scotia,

unless the same is accompanied by a certificate of inspection signed by an authorized inspector, which states that the said stock, seedlings, scions, buds or grafts have been duly treated in accordance with the instructions of the Department of Agriculture and is free from the apple sucker, *Psyllia mali* Schmidb. This new European pest was discovered in the summer of 1919. The above regulation has been passed in order to prevent its further spread on infested scions, nursery stock, etc.

1920-1921

By Order in Council dated April 14, 1920, the importation into Canada of alfalfa (lucerne) hay, whether for feeding, packing or other purposes, originating in the states of Idaho, Utah, and also in the counties of Uintah, Sweetwater and Lincoln in the state of Wyoming, and the counties of Dennison and Gunnison in the state of Colorado, four of the United States of America, is prohibited.

This amendment was passed in order to assist in preventing the introduction of the alfalfa weevil into Canada on shipments of alfalfa hay.

By Order in Council dated May 24, 1920, the amendment dealing with the European corn borer passed on May 19, 1919, was rescinded. Under the new amendment the importation into Canada of corn and broom corn, including all parts of the stalk, celery, green beans in the pod, beets with tops, spinach, rhubarb, oat and rye straw, as such or when used as packing, cut flowers or entire plants of chrysanthemums, aster, cosmos, zinnia, hollyhock, gladiolus and dahlia from the areas in the United States infested by the European corn borer is prohibited, unless the same are accompanied by a certificate of inspection issued by the United States Department of Agriculture stating that the above products are free from the pest.

By Order in Council dated August 21, 1920, the amendment dealing with the apple sucker passed on November 28, 1919, was rescinded and substituted by a Ministerial Order. Under this Ministerial Order the counties of Kings, Hants, Colchester, and Cumberland, in the province of Nova Scotia were quarantined on account of the apple sucker, and no nursery stock may be moved from any of the quarantined areas unless accompanied by a permit or a certificate of inspection duly signed by an authorized inspector.

By a Ministerial Order passed on September 16, 1920, the removal of corn, including all parts of the plant, from the London, Ont. fair grounds was prohibited on account of the danger of spreading the European corn borer thereby.

On September 25, 1920, a Ministerial Order was passed adding the communities of Aldersville, New Ross and Mill Road, in the county of Lunenburg, Nova Scotia, to the areas mentioned in the quarantine passed on August 21, 1920, under which the removal of nursery stock is prohibited owing to the danger of spreading the apple sucker.

On November 25, 1920, a Ministerial Order was passed prohibiting the removal of corn fodder or cornstalks, including broom corn, whether used for packing or other purposes, green sweet corn, roasting ears, corn on the cob or corn cobs, from the areas in southern Ontario infested by the European corn borer. Five exceptions were made to this quarantine, namely:—

1. To the articles enumerated when they shall have been manufactured in such a manner as to eliminate the risk of carriage of the European corn borer
2. To clean shelled corn and cleaned seed of broom corn.
3. To shipments of the articles enumerated, transported through the quarantined areas on a through bill of lading.
4. To shipments of the articles enumerated for experimental or scientific purposes, by the Dominion Department of Agriculture or the Ontario Department of Agriculture.

5. To shipments of dried seed corn on the cob for exhibition purposes and consigned to the secretary of a winter fair or exhibition duly recognized by the Dominion Department of Agriculture or the Ontario Department of Agriculture. Such shipments shall be inspected at point of destination by an inspector duly appointed under the Destructive Insect and Pest Act.

By Order in Council dated February 25, 1921, that part of section 3 of the Regulations under the Destructive Insect and Pest Act passed on July 17, 1917, and reading as follows, was rescinded:—

“Truro, N.S., and Digby, N.S., for nursery stock destined to points in the province of Nova Scotia only, from March 15 to May 15, and from October 7 to December 7.”

III—THE NATIONAL COLLECTION OF INSECTS.

Considerable progress was made during the two years covered by this report in the arrangement of the National Collection of Insects. On April 1, 1919, Dr. J. H. McDunnough, a systematist of high standing, was appointed Chief of the Division of Systematic Entomology. Through the efforts of this officer, assisted by other entomologists in the branch, large accumulations of unclassified insects have been worked over and placed in correct systematic positions. The species of the various orders of insects have been transferred to permanent steel cabinets.

Special cabinets for the reception of alcoholic material were received, and Mr. Paul N. Vroom was engaged during the winter months in arranging such material, particularly the spiders (Arachnidæ).

In November, 1919, Mr. August Busck, of the United States National Museum, Washington, D.C., visited the branch and rendered valuable assistance in arranging the collection of Microlepidoptera. Dr. Harrison G. Dyar, of the same institution, also visited Ottawa for the purpose of examining the collection of mosquitoes.

ADDITIONS TO COLLECTIONS. From British Columbia valuable collections of insects have been received from Messrs W. Downes, W. B. Anderson, E. H. Blackmore, W. R. Buckell, and E. R. Buckell. Many specimens from Alberta have been contributed by Messrs. F. Carr, K. Bowman, D. Mackie, F. Whitehouse and E. H. Strickland. From Manitoba collections have been received from Messrs. Norman Criddle, J. B. Wallis, P. N. Vroom and Mrs. W. Hippisley. Material collected in Ontario has been received from Messrs. W. A. Ross, H. F. Hudson, and J. F. Brimley. From the Yukon Territory valuable specimens were donated by Mr. A. P. Hawes. Various officers of the Geological Survey, notably Messrs. C. H. Young, C. M. Barbeau, and H. C. Cook, have collected material for the National Collection.

Dr. W. Barnes, of Decatur, Ill., very kindly donated a number of species of lepidoptera, including paratypes of species described from Canadian material.

The most important addition to the National Collection was the very valuable collection of lepidoptera of the late F. H. Wolley-Dod, which was bequeathed to the branch. This collection consisted of over 20,000 specimens. It is particularly rich in noctuidæ, of which family Mr. Dod was a recognized authority.

FIELD WORK. In 1919, Dr. McDunnough made large collections in the Ottawa district and also began a faunal study in the Lake of Bays region of northern Ontario. In the following year this district was again visited, special attention being given to the collecting of specimens of odonata and neurop-

teriod insects. These latter insects are of considerable economic interest from the fact that their larvæ constitute to a considerable extent the food of important fishes.

COLLECTIONS OF THE CANADIAN ARCTIC EXPEDITION. During the two years under review studies of collections of insects made by members of this expedition were completed and reports published on collembola, neuropteroid insects; diptera; mallophaga and anoplura; coleoptera; hemiptera; hymenoptera and plant galls; spiders, mites and myriopods; lepidoptera; and orthoptera. These reports are valuable contributions to the literature of arctic insects.

The specimens, with the types of those described as new to science, have been deposited in the National Collection.

ACKNOWLEDGMENTS: Our thanks are due to a number of specialists in the United States and elsewhere, who have helped us in determining specimens. In this connection we are specially grateful to Dr. L. O. Howard, Chief of the United States Bureau of Entomology, and his colleagues at Washington, D.C.

The Chief of the Division of Systematic Entomology has rendered much help to entomologists, teachers and others, in the determination of doubtful material.

IV—BRANCH LABORATORIES.

ANNAPOLIS ROYAL, N.S., Mr. G. E. Sanders, Entomologist in charge. The officer at this laboratory was in immediate charge of insecticide investigations of the branch. This latter work is referred to particularly on page 25. Successful orchard and field demonstrations have impressed the growers of the Maritime Provinces of the importance of this work and as a direct result larger and better crops have been grown. Through the studies of the officers at this laboratory in developing improved insecticides, important financial savings to fruit growers have resulted. In addition to the insecticide investigations which were carried on at this laboratory, studies have also been made of important outbreaks of insects occurring in Nova Scotia. A rather widespread outbreak of the true armyworm was investigated in 1920, resulting in an opportunity of demonstrating under field conditions successful control by means of poisoned baits.

FREDERICTON, N.B., Mr. J. D. Tothill, Entomologist in charge. At this laboratory the various causes of insect outbreaks have received close investigation. The study of the natural control of such important pests as the fall webworm, the forest tent caterpillar and the spruce budworm was continued. Important parasites of the brown tail and gipsy moths which were introduced into New Brunswick and Nova Scotia, were recovered during 1920; one important parasite, namely *Apanteles lacteicolor* Vier., has increased considerably. A further statement regarding natural control investigations will be found on page 26. Outbreaks of important pests such as the tent caterpillar, birch leaf skeletonizer, spruce budworm, army worm, etc., have been investigated.

HEMMINGFORD, QUE., Mr. C. E. Petch, Entomologist in charge. Orchard demonstrations with various spray and dust mixtures occupied much of the time of the officer in charge of this laboratory during 1919 and 1920. Orchard and field demonstrations with various insecticides have attracted considerable attention. Life-history studies of important pests such as the apple curculio and the plum curculio have been made. In addition, the following are the insects which have been most destructive in Quebec province in the two years covered by this report: flea beetles, fruit worms, cutworms, root maggots, white grubs and budmoth.

VINELAND STATION, ONT., Mr. W. A. Ross, Entomologist in charge. Life-history studies of the pear psyllia commenced in 1917 were largely completed in 1919 and much valuable data on its control was obtained. In the same year investigations on the strawberry weevil and potato leaf hopper were begun and satisfactory progress made. Orchard demonstrations in the control of a number of fruit pests were conducted in various sections of the Niagara district. Experiments with various orchard dusts and new spray materials were also undertaken. Systematic studies of the various species of aphids found in Canada were continued by the officer in charge of this laboratory.

STRATHROY, ONT., Mr. H. F. Hudson, Assistant Entomologist in charge. The important lines of investigations carried on in 1919 at this laboratory were the continuation of the life-history studies of white grubs and other soil-infesting insects and demonstrations of insecticides valuable for controlling the Colorado potato beetle, and experiments on the control of the potato leaf hopper. An infestation in western Ontario of the Hessian fly received attention. In the following year this latter insect was again destructive to wheat in western Ontario. In addition to the above, other insects which were studied, were the seed-corn maggot, cabbage root maggot, wireworms, etc.

TREESBANK, MAN., Mr. Norman Criddle, Entomologist in charge. In 1919, owing to the very serious outbreak of grasshoppers in the southwestern sections of Manitoba and southeast Saskatchewan, the officer in charge of this laboratory devoted the major portion of the summer to visiting grasshopper infested areas, giving advice to farmers and demonstrating the value of poisoned baits and other control measures. In 1920, the continued outbreak of grasshoppers in Manitoba again necessitated Mr. Criddle's personal attention during most of the season. In May, June, July, and August of this latter year meetings of farmers in infested districts were addressed, bait-mixing stations were visited and advice in general given. Outbreaks of other field crop insects such as the western wheat-stem sawfly, cutworms, sugar beet webworm, blister beetles, diamond-back moth, etc., were investigated.

SASKATOON, SASK., Dr. A. E. Cameron, Entomologist in charge. The grasshopper outbreaks in this province in 1919, like those in Manitoba, necessitated the attention throughout the growing season of the officer in charge of this laboratory. Many farmers' meetings were held and definite instructions given regarding the control of these destructive insects. Our officer worked in close co-operation with provincial officers. In the same year, as time permitted, investigations were made on insects affecting live stock. In 1920, in addition to assisting in the grasshopper campaign, Dr. Cameron continued investigations on the biology of such pests as black flies, horse-flies, etc. Outbreaks of cutworms were also studied as well as infestations of the beet webworm, which was prevalent in the province.

LETHBRIDGE, ALTA., Mr. E. H. Strickland, Entomologist in charge. Cutworm studies occupied the attention of the officer in charge of this laboratory. In 1919, a very severe outbreak of these caterpillars occurred in Alberta; in fact, probably the most extensive outbreak in the history of the province. Many thousands of dollars' worth of growing crops were destroyed, particularly by the pale western cutworm. In the following year field experiments in cutworm control were conducted as well as studies on parasites attacking these caterpillars. In 1920, grasshoppers were very abundant, particularly in southern portions of the province. From the end of May until late in the season the services of our resident field officer were required in the campaign of control. This work resulted in the saving of much crop from destruction.

VERNON, B.C.; VICTORIA, B.C.; AGASSIZ, B.C., AND MISSION, B.C. Mr. R. C. Treherne has had general supervision over all the entomological work in British Columbia. In the Vernon district important investigations were con-

ducted on the life-history and control of orchard and small fruit insects, such as the codling moth, currant fruit fly, etc., as well as vegetable insects, particularly the cabbage root maggot and the onion maggot. Investigations relating to insects affecting range lands, especially grasshoppers, were also conducted from this laboratory.

At the Victoria laboratory, Mr. W. Downes had charge of investigations relating to strawberry insects, particularly the strawberry root weevil. Through the co-operation of the Provincial Department of Agriculture office accommodation was provided for Mr. Downes in the Parliament Buildings and all enquiries received at the Provincial Department of Agriculture relating to insects were referred to our officer.

At the Agassiz laboratory, Mr. A. B. Baird was in temporary charge. The work of this officer was concerned particularly with the natural control of insects, and studies were made of important parasites of the tent caterpillar, the fall webworm and the spruce budworm.

The laboratory at Mission for mosquito investigations was established in 1919 with Mr. Eric Hearle, Assistant Entomologist, in charge. This work is referred to particularly on page 24.

V—MISCELLANEOUS.

GOPHER CONTROL BY MEANS OF CHLORINE

While in Saskatchewan in 1920, Mr. Kelsall experimented with varying amounts of chlorine which were liberated down holes into which the gophers had been seen to go. Chlorine gas, being heavy, sinks directly into the holes. In reporting upon these experiments he stated as follows:—

EXPERIMENT No. 1. (a) Holes into which a small puff of gas had been liberated. A few seconds after liberation of gas the gophers emerged from the holes. They were in a dazed condition, considerably distressed, and it was thought they might stand a chance of eventually recovering.

(b) Holes into which a little more chlorine than the above was liberated. A few seconds after liberation of gas the gophers came to the mouth of the hole where they remained gasping and in great distress. These gophers died in times varying from half a minute to two minutes after appearing at the mouth of the hole.

(c) Holes into which still more chlorine than the above was liberated. These gophers did not appear at all, and it was evident that they had died almost immediately in the hole.

EXPERIMENT No. 2. A cylinder of chlorine having a rubber exit tube attached was placed in a wagon and conveyed to an area where gophers were very numerous. Before commencing operations the total weight of the cylinder was noted. The time chosen was about 6 p.m. when it was known that the largest number of gophers would be out of their holes.

While driving it was noted which particular holes gophers went in (many holes were old and apparently deserted), and the wagon taken near such holes. The opening of the rubber tube was then placed at the mouth of the hole and gas turned on for one or two seconds. In each case it was the aim to liberate about the same quantity of gas as that used in Experiment 1 (c), or an amount somewhat exceeding this. It is to be noted that no longer time than a few seconds was taken at each hole. It was not necessary to get out of the wagon.

In no cases did gophers appear again on the surface after the gas had been liberated. In this way chlorine was liberated in forty-two holes, in many of which more than one gopher was known to be. It was found on again weighing the cylinder that a little less than four pounds of chlorine had been used to gas the forty-two holes.

INDIAN ORCHARD WORK IN BRITISH COLUMBIA

In the years covered by this report (1919 and 1920), the work amongst the Indians in the province of British Columbia, for which provision is made by the Department of Indian Affairs, has been under the direction of the Dominion Entomologist, the officer in immediate charge being Mr. Walter B. Anderson, Supervisor of Indian Orchards in British Columbia.

This work being of a general agricultural and horticultural nature is especially concerned with educational matters, such as the pruning, the removal of worthless trees which afford breeding places for pests, the control of orchard insects by proper spraying methods, etc. During the winter months and at other times as well, various reserves have been visited and lectures given on fruit growing, injurious insects, value of bird protection, etc. In some sections spraying machines have been installed and demonstrations given in the preparation of standard spray mixtures. Many of the Indians have become excellent operators of these machines and, as a result, orchards have been protected from important pests and improved crops of fruit secured. From the reports received from Mr. Anderson, and from observations which I have personally made, there has undoubtedly been marked improvements in the Indian orchards of British Columbia, as a result of this work.

TRAVELLING

Visits have been made by me personally to the entomological field laboratories in the various provinces to see the work of our officers and the districts in which such investigations were being conducted. Meetings of various societies have also been attended. In December, 1919, I represented the branch at the annual meetings of the American Association of Economic Entomologists, and Entomological Society of America, which was held at St. Louis, Mo. At the end of the year 1920, I attended similar meetings of the same societies at Chicago, and was elected Vice-President of both societies. Dr. Swaine also attended these latter meetings. In September, 1920, I visited the United States Bureau of Entomology laboratories, near Boston, Mass., namely the gipsy and brown tail parasite laboratory at Melrose Highlands, and the European corn borer laboratory at Arlington. In the same month, accompanied by Mr. McLaine, I also visited corn borer infested regions near Buffalo, N.Y. During the years 1919-20 and 1920-21, I had the honour of being elected President of the Entomological Society of Ontario.

ADVISORY BOARD ON WILD LIFE PROTECTION

In December, 1920, I was appointed by Order in Council a member of the Advisory Board on Wild Life Protection. This board is an interdepartmental one, the function of which is to advise the various Government departments in matters relating to wild life protection, as well as in advising provinces concerning wild life problems which they refer to the board. The Departments represented on this board are: Agriculture, Indian Affairs, Mines, Interior, Fisheries and Mounted Police.

PUBLICATIONS

The following bulletins, circulars and leaflets have been published during the two years ending March 31, 1921:—

BULLETINS

Studies in North American Cleorini (Geometridae). By J. H. McDunnough, Bulletin No. 15, 64 pp., issued November 19, 1920.

CIRCULARS

- Boring Caterpillars Affecting Corn and other Crops and which are Liable to be Mistaken for the European Corn Borer. By Arthur Gibson, Circular No. 14, 14 pp., issued April 9, 1920.
- Locust Control in the Prairie Provinces. By N. Criddle, Circular No. 13, 20 pp., issued April 13, 1920.

CROP PROTECTION LEAFLETS

- How to Control Locusts or Grasshoppers. By A. Gibson and N. Criddle, Crop Protection Leaflet No. 6, 4 pp., issued June, 1919
- The Beet Webworm. By E. H. Strickland and N. Criddle, Crop Protection Leaflet No. 12, 3 pp., issued November, 1919.
- The European Corn Borer. By A. Gibson and L. S. McLaine, Crop Protection Leaflet No. 13, 3 pp., issued September 24, 1920.
- The Control of Grasshoppers. By N. Criddle and A. V. Mitchener, Crop Protection Leaflet No. 14, 4 pp., issued March, 1921.
- The Date on which it is safe to Re-seed Fields in the Prairie Provinces after they have been Devastated by Cutworms. By E. H. Strickland. Crop Protection Leaflet No. 11, pp. 2.

In addition to the above publications issued by the Branch, an illustrated bulletin on the apple maggot—32 pp.—was prepared jointly by L. Caesar, Provincial Entomologist, and W. A. Ross, in charge of our Vineland Station, Ont., laboratory, and published by the Ontario Department of Agriculture in May, 1919.

The following articles have been published in the Agricultural Gazette of Canada:—

- The Poplar Borer, *Saperda calcarata* Say. By R. N. Chrystal, Vol. 6, No. 4, pp. 333-337, April, 1919.
- The European Corn Borer, *Pyrausta nubilalis* Hubner, A New and Most Dangerous Pest. By L. S. McLaine, Vol. 6, No. 5, pp. 443-446, May, 1919.
- The Greenhouse Leaf-Tyer, *Phlyctaenia ferrugalis* Hbn. By Arthur Gibson, Vol. 6, No. 7; pp. 626-629, July, 1919.
- The European Elm Sawfly Leaf-Miner. By R. N. Chrystal, Vol. 6, No. 8, pp. 725-728, August, 1919.
- The Corn Ear Worm in Consignments of Imported Tomatoes. By A. Gibson, Vol. 6, No. 9, pp. 797-799, September, 1919.
- The Use of the Aeroplane in Entomological Work. By C. Gordon Hewitt, Vol. 6, No. 10, p. 877, October, 1919.
- The Use of White Arsenic as an Insecticide in Bordeaux Mixtures. By G. E. Sanders and A. Kelsall, Vol. 7, No. 1, pp. 10-12, January, 1920.
- The Pine Bark Beetle Outbreaks. By J. M. Swaine, Vol. 7, No. 8, pp. 642-644, August, 1920.
- What is Entomology? By J. H. McDunnough, Vol. 7, No. 9, pp. 739-740, September, 1920.
- Two New and Important Insect Pests Recently Found in Canada.¹ By L. S. McLaine, Vol. 7, No. 10, pp. 793-794, October, 1920.
- Gopher Control by Means of Chlorine. By A. Kelsall, Vol. 7, No. 11, pp. 879-880, November, 1920.
- The European Corn Borer Infestation. By L. S. McLaine, Vol. 7, No. 12, pp. 938-939, December, 1920.
- A Survey of Our Forests From the Air. By J. M. Swaine, Vol. 8, No. 1, pp. 20-22, February, 1921.
- The Value of Insectivorous Birds to Agriculture. By Arthur Gibson. Vol. 8, No. 2, pp. 126-127, March, April, 1921.

In addition to the above, officers of the branch have contributed important scientific articles to *The Canadian Entomologist* and other entomological journals; as well as popular articles, relating to the habits and control of important insect pests, to agricultural and other papers.

¹ European Corn Borer and Satin Moth.

STAFF

During the two years ending March 31, 1921, the following permanent technical officers were appointed to our staff:—

- J. H. McDunnough, Ph.D., Chief, Division of Systematic Entomology, Ottawa, Ont.
- Ralph Hopping, Entomologist, in charge of forest insect investigations in British Columbia, Vernon, B.C.
- H. G. Crawford, B.S.A., Entomologist, Division of Field Crop and Garden Insects, Ottawa, Ont.
- F. C. Craighead, Ph.D., Entomologist, Division of Forest Insects, Ottawa, Ont.
- H. L. Seamans, B.Sc., Entomologist, in charge of Lethbridge, Alta., laboratory.
- R. P. Gorham, B.S.A., Assistant Entomologist, Fredericton, N.B.
- E. Hearle, B.S.A., Assistant Entomologist in charge of mosquito investigations in western Canada.
- V. B. Durling, Junior Entomologist, Annapolis Royal, N.S.

The following resignations took effect:

- A. E. Cameron, D.Sc., in charge of Saskatoon, Sask., laboratory.
- R. N. Chrystal, B.Sc., Assistant in the Division of Forest Insects, Ottawa, Ont.
- A. McMahon, B.S.A., Assistant, Annapolis Royal, N.S., laboratory.

It is very gratifying to record the loyal support I have received from all members of the staff since my appointment as Dominion Entomologist and Head of the Entomological Branch. In my opinion in no branch of the public service is there to be found a better spirit of co-operation than that which exists in the Entomological Branch. Our officers, both technical and clerical, without exception, have rendered splendid service, as a result of which the standing of entomology in Canada has been considerably advanced.

I have the honor to be, sir,

Your obedient servant,

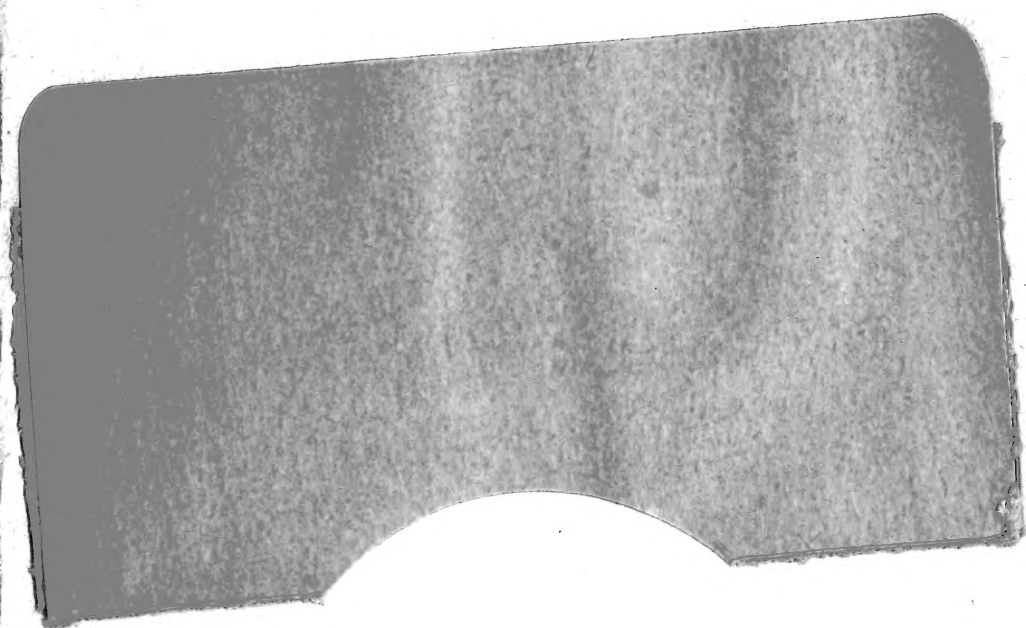
ARTHUR GIBSON,
Dominion Entomologist.

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